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THE UNKNOWABLE.

By Richard A. Proctor.

A DIGRESSION CONCERNING THE NAME AND PURPOSE OF THESE PAPERS.

AS the purpose of this series of articles—originally indicated very fully—seems to have been forgotten by many, and several correspondents, as well as outside critics, have renewed the old mistake of describing the Unknowable as that of which we neither know nor can conceive anything, I make here a few remarks as to the fundamental idea on which the recognition of the Unknowable depends.

To unthinking persons, having it may be feared somewhat shallow minds, it appears as though there could hardly be a much greater blunder than to speak of the Unknowable as if we knew aught about It. Even one of comparatively trained, though somewhat fanciful mind, like Mr. Frederick Harrison, could jeer at Mr. Spencer for going so far as to speak of the Power which lies at the back of all phenomena as certainly unknowable; for, said Mr. Harrison, it is "more philosophical not to assert of the unknown that it is unknowable." Again, "to assert the presence of one uniform energy," said Mr. Harrison, "is to profess to know something very important about the Unknowable," as if nothing could possibly be known about that which is admitted to be unknowable.

But in reality we not only know something, we know what for us is *much* about the Unknowable. It may truly be said that *all* we know is knowledge about the Unknowable. This sounds like saying, "We know all about the Unknowable," or, more shortly, "We know the Unknowable," either of which is an utterly self-contradictory saying. But in reality there is no such contradiction. Nay, one may present with truth a seemingly more obvious paradox: for one may truly say—

Everything we know we know about the Unknowable, yet of the Unknowable we know (in effect) nothing.

This which seems so obviously and undeniably absurd is simply a truism to all who have been led to contemplate the Unknowable by advancing along the track which the students of the knowable have followed until now, and which I am tracing in these papers.

In order to show that, instead of being a paradox, the saying just imagined is a mere truism (in these days, and for the thoughtful student of science), we may compare it with either of the following manifest truisms:—

Everything we know we know about the Universe; yet of the Universe we know (in effect) nothing.

Everything we know about the occurrence of events we know about events occurring during all Time; yet of the events occurring during all Time we know (in effect) nothing.

Everything we know about the dimensions of bodies and systems in space around us, we know about bodies and systems occupying infinite space; yet of Infinite Space we (in effect) neither know nor can conceive anything.

Everything we know we know about the Infinite, for the Finite is a part of the Infinite; yet of the Infinite we (in effect) neither know nor can conceive anything.

We need not take infinity, however, to find similar apparent contradictions, which are in reality no contradictions at all. Thus we may write:—

The distances of the millions of stars in our galaxy are unknown and unknowable; yet we know much about those distances.

The region around the earth's centre is unknown and unknowable; yet we know much about its nature and condition.

The depths of ocean must be regarded as unknown and unknowable; yet we know a good deal about those depths and their tenants.

Or, to turn from the great to the small:—

The ultimate structure of microscopic forms (animate and inanimate) is unknown and unknowable; yet we know a good deal about it.

Or, to take concrete examples:—

The Emperor of All the Russias is unknowable for some average Englishman, whose whole life is passed, say, in Truro; and the Cham of Tartary may even be so far unknowable that of his actual existence to-day such an Englishman may be doubtful: yet that same Englishman, if decently educated, as an average Englishman may be expected to be, knows a good deal about the Emperor of Russia, and could quote many passages from well-known authors relating to the Cham of Tartary, in the days when the Cham of Tartary was a recognised power.

What I am trying to do in these papers is to show how men of all races and in all ages have recognised mystery and power in the unknown which was for them unknowable, their ideas of the unknown power widening as the domain of the known widened and so disclosed the ever-widening domain, the ever-deepening mystery of the unknown and the unknowable, until now the Unknowable is recognised as without limits either in time or space. Its mystery is too profound to be fathomed.

That this should seem like atheism to the ignorant, who either need and believe in a finite deity, or else reject with unnecessary indignation a deity of that sort (the only deity suiting ignorant minds), is natural enough. As a shallow critic has remarked in the pages of a contemporary—Religious and irreligious, meaning those who arrogate to themselves the title religious and those who as arrogantly reject religion, agree in recognising Darwin and Spencer, Huxley and Tyndall, and all who think like them, as atheists. But then, the opinions of such persons count simply as nothing. The early Christians were promised safety if they abjured atheism, and doubtless their belief seemed like atheism to the believers in the divinity of sun, moon, and planets, or of other nature-gods; but the early Christians knew that they were not atheists, and regarded the belief of those outside their body as the true atheism for their day. So the student of science of our day knows that his belief is not atheism, but that it would be actual atheism *in him* to accept the finite deity believed in by the ignorant (a deity, to use Matthew Arnold's words, not less familiarly known than "some angry man in the next street") as truly representing the Infinite Power which resides in all things, and of which all phenomena are the unexplained and inexplicable manifestations.

XUM

Even Agnosticism, if it be interpreted to signify know-nothingism, is a most unsuitable word for the belief which recognises the Infinite as Unknowable. I am not concerned that Mr. Huxley may have expressed a certain modified approval of this term. Darwin differentiated Agnostic from Atheist by saying that Agnostic is merely Atheist writ respectable, and Atheist Agnostic writ aggressive. But the fact really is that science has been led to its present position by considering the known rather than the unknown, the knowable rather than the Unknowable. Science is able to say we *know* that Deity is not what the savage thinks and has thought it; we *know* that the wind and the storm, the earthquake and the volcano, plague and pestilence, sun, moon, and planets, are not as gods, knowing good and evil; we know even that the thoughts and emotions of man, his power of looking before and after, of distinguishing right from wrong, and of ruling his own nature accordingly—more and more perfectly as the race advances in development—only symbolise the qualities of the personality, if so one may describe it, of the Power working in and through all things. "That which wells up in us as consciousness" is doubtless a portion of "the power manifested throughout the universe distinguished as material"; and perhaps that which we recognise as conscience is a manifestation of the nature of the same power existing throughout the universe in its non-material aspect. It may well be that hereafter higher powers, as yet unimagined, may give us further symbolisations of that infinite power. But most assuredly the progress of science thus far has not been from recognition towards rejection of such a power, though at each step false ideas of Deity have been rejected as the mist through which they had loomed misshapen has cleared, until at last the purest conception of infinite power yet obtained by man has been reached. To those who see matters thus, the idea of Deity entertained by those who denounce the student of science as an atheist, appears truly atheistical—in this sense, that it presents to him, for adoration as Deity, the finite, the limited, the imperfect, nay, the evil, and even the horrible.

If we picture to ourselves the progress of men in this matter even until now, we may find it truly presented, as in a parable, in the vision of Elijah after his forty days' fast. The child-man of old recognised infinite power, transcending nature, when "the great and strong wind rent the mountains, and brake in pieces the rocks"—"but the Lord was not in the wind." And after the wind the powers of the earth's interior typified the Unknowable; "but the Lord was not in the earthquake." And then the sun and stars, with that earth-born child of the sun, Fire, appeared to men as the infinite power, working in and through all things; "but the Lord was not in the fire." And now in the workings of man's moral and emotional nature, the "still small voice" which tells us of something other than that material power whereof mere consciousness speaks, many recognise the manifestation of the Infinite. But God is not in the "still small voice"; that voice is in Him. Man does not feel the Godhead in him; he feels himself in the Godhead. He who thus thinks of Deity as absolutely infinite, yet as manifested in the finite, and rejects all such teachings about deity as falsely proclaim the infinite to *be* finite, and ascribe the same passions and the same weaknesses to Infinite Power which characterise us, the imperfect and the weak, may say with Elijah of old: We are "very jealous for the Lord"—our God—the Infinite Power working in and through all things. We do not denounce those whose ideas are less advanced—denunciation is for those of little faith—but we do proclaim, and as loudly as we may, that for *us* to teach as they do would not only be to offer to the Infinite "the unclean sacrifice of a lie," but would be nothing short of blasphemy.

THE WORSHIP OF THE PLANETS.

(*Continued from* p. 203.)

The offerings and sacrifices made by the Jews in old times on the Sabbath day and on the festival of the new moon (the beginnings of the months) show something, as I have said, of the nature of the observances prevalent among the Sabaistic nations from whom the Jewish sacrificial system was derived. We may with advantage consider what the injunctions addressed by the Jewish legislators to their people on these points really imply. No one who examines the matter reasoningly, and apart from preconceived prejudices, can fail to see that however suitable these observances doubtless were for nations regarding the sun, moon, and planets as real gods, not too far away to welcome with pleasure the smoke and smell through which the essence of the burnt offerings (their food) was absorbed by them, they would be absurd, even as symbolisations, for men recognising the heavenly bodies for what they are, and—above all—our earthly abode for what it actually is.

Thus run these ordinances, to regard which as divine would be blasphemy for any one who has formed other than such gross conceptions of Deity as suited perfectly the infancy of the human race:—

"And on the Sabbath day (ye shall offer) two he-lambs of the first year without blemish, and two tenth parts of an ephah of flour for a meal offering, mingled with oil, and the drink offering thereof; this is the burnt offering of every Sabbath, beside the continual burnt offering and the drink offering thereof."

"And in the beginnings of your months ye shall offer a burnt offering unto the Lord, two young bullocks and one ram, seven he-lambs without blemish; and three tenth parts of an ephah of fine flour for a meal offering, mingled with oil, for each bullock; and two tenth parts of fine flour for a meal offering, mingled with oil, for the one ram; and a several tenth part of fine flour mingled with oil for a meal offering, unto every lamb; for a burnt offering of a sweet savour, an offering made by fire, unto the Lord. And their drink offerings shall be half an hin of wine for a bullock, and the third part of an hin for the ram, and the fourth part of an hin for a lamb; this is the burnt offering of every month throughout the months of the year. And one he-goat for a sin offering unto the Lord; it shall be offered beside the continual burnt offering, and the drink offering thereof."

The rest on the day devoted to Saturn, and the idea that such rest could in any way delight the Infinite, must be regarded as in like manner belonging to the childhood of a race—in other words, to the era of semi-barbarism. The same race which could believe that their own particular god would take pleasure in seeing a people which, in its savage stage, was one of the most brutal and hateful this world has known, destroying and enslaving races not quite so barbaric and altogether less hateful than themselves, might well believe that that same God derived pleasure from their weekly rest—as indeed any respectable deity, or even Jupiter or Apollo, might very reasonably have done, seeing that whenever they were not at rest they were at mischief. But to attribute such ideas to an Infinite All-knowing Power would be simply blasphemous.*

The Jews, following the worshippers of the planets, believed also that yet more trifling ceremonies were of

* Perhaps the oddest notion of the early Jews was that Yahveh needed to be reminded by loud noise-making when He was to look after their interests during any of their abominable wars. "When ye go to war in your land against the adversary that oppresseth you, then ye shall sound an alarm with the trumpets, and ye shall be remembered before the Lord your God, and ye shall be saved from your enemies."—Numbers x. 9.

importance in the eyes of their God. "The Lord spake unto Moses" (so Moses said), "saying, Speak unto Aaron, and say unto him, when thou lightest the lamps, the seven lamps shall give light in front of the candlestick. . . . And this was the work of the candlestick, beaten work of gold—unto the base thereof, and unto the flowers thereof, it was beaten work. According unto the pattern which the Lord had showed Moses, so he made the candlestick"—that seven-fold candlestick by which the lights burning for the seven planets were originally supported.

THE STORY OF CREATION.

A PLAIN ACCOUNT OF EVOLUTION.

By EDWARD CLODD.

VIII.—EXISTING LIFE-FORMS (*continued*).

A. *Plants.*

PLANTS are divided into two main groups or sub-kingdoms; I. Cryptogams (Gr. *kruptos*, hidden; *gamos*, marriage), or flowerless; II. Phanerogams (Gr. *phaneros*, open; *gamos*, marriage), or flowering.

I. The Cryptogams comprise as their leading representatives:—1. Algæ, Fungi, Lichens; 2. Liverworts, Mosses; 3. Ferns, Horsetails, Clubmosses. The feature common to these is the absence of any conspicuous organs, i.e. true flowers with stamens and pistils for the production of seeds or fruits. The simplest or single-celled plants increase by sub-division, each cell carrying on an independent life and repeating the process of division. But sexuality is manifest in plants very low down in the scale, the mode of reproduction varying a good deal in different species. In some cryptogams it is almost as complex as in the flowering plants, but notwithstanding the different kinds of sexual organs, there is this fundamental resemblance between them, that the union of the contents of two cells, a male or sperm-cell, and a female or germ-cell, each of which is by itself incapable of further development, is essential to the production of the embryo or seed.

The lowest cryptogams have no stems, leaves, or roots. They are congregations of simple fibreless cells united in rows, or gathered round one another, spreading on all sides. At the bottom of the scale of plant-life are the *Algæ*, comprising some 10,000 species, from the minute fresh-water desmids one-millionth of an inch in length, with their whip-like cilia the two hundredth millionth of an inch long, to the giant sea-weeds or tangles, hundreds of feet in length, that cover thousands of square miles of ocean. The green scum of stagnant ponds; the waving filaments in streams; the shell-coated microscopic diatoms that people the ocean, tinging its depths with olive-green, nourishing the whales that play therein, and whose skeletons form deposits hundreds of miles in length; the rose and purple weeds that flourish in shallow seas, and are cast upon their shores; are all members of a group which is perhaps the venerablest of living things. For although their generally fragile forms have been fatal to their preservation as fossils, there is little doubt that the algæ flourished in dense masses in primæval oceans, and were the chief, if not the sole, representatives of plant-life on the earth during millions of centuries. Like the foraminifera and other low animal organisms, they illustrate the persistency of the earlier forms, in virtue of their simplicity of structure, despite changing conditions, whereas the more complex structures, by reason of the greater delicacy of their parts, can less readily adapt themselves to altered surroundings, and therefore have a much narrower distribution both in time and space.

Next to the algæ in ascending order are those fantastic products of decay, the quick-growing, short-lived *Fungi*, animal-like in their mode of nutrition, plant-like in their fixity; then the *Lichens*, which, it is now generally agreed, are composite plants, being a special kind of parasitic fungi growing on algæ. These are widely spread, living, after the adaptive manner of simple forms, where nothing else can live, unwithered by the heat, unsmitten by the frost; redeeming the earth's desolate places, from treeless desert flats far as the lines of enduring snow; spreading their flowerless patches of richest colours in metallic-like stains over rock and ruin; encrusting the trees with tint of freshness or touch of age, with hoary fringe or mock hieroglyph; and in their decay yielding rich soil wherein fern and flowering tree may strike root.

In the *Mosses*, whose glossy, many-coloured masses weave softest carpet over the earth, sharing in the service rendered by the humble lichens, the cells have become more developed into rudimentary root, stem and leaf, manifesting still further transition towards unlikeness in parts due to division of function. But the structure is still cellular—i.e. there are no tissues and fibres. The mosses represent the intermediate forms between the lowest and the highest cryptogams, between the green algæ—out of which the liverworts were probably developed—and the ferns, which arose out of liverworts.

In the *Ferns*, the larger number of cells have joined together to form fibrous vessels, lengthening or thickening in varying shape and texture according to the functions to be discharged by them, resulting in the woody tissue which enters into the structure of all the higher plants. The cells, which are thus converted into tissue, cease to grow; the formative protoplasm becomes the formed, having given up its life for the plant, and locked up in the compacted material a store of energy for service both within the plant and by the agency of the plant. The ferns and clubmosses and horsetails of the present day are the dwarfed representatives of the stately and luxuriant, although sombre, flowerless trees that composed the dense jungles of green vegetation in the Devonian and succeeding Primary periods. These are distinguished as the Era of Fern Forests, during which our fossil fuel was chiefly formed; and although the palm-like vegetation of the tropics more nearly approaches its Devonian prototype, it falls far behind it in size and abundance.

II. The Phanerogams have their flowers with stamens and pistils conspicuous, and are divided, according to the formation of their seeds, into:

1. Gymnosperms, or naked-seeded, the ovules not being inclosed within a seed-vessel or ovary, but carried upon a cone, as in pines and allied species.

2. Angiosperms, or cover-seeded, the ovules being inclosed within an ovary.

This group is subdivided into (*a*) plants having one seed-leaf from which they are developed, as palms, lilies, orchids, grasses; and into (*b*) plants having two seed-leaves, as oaks, beeches, and all trees and shrubs not included in the foregoing species.

In naked-seeded plants the pollen or male element falls on the exposed ovules; in cover-seeded plants it falls on the stigma, passes down the pistil into the seed-vessel, and enters the ovule through an opening in it called the micropyle, or "little gate."

Whilst the gymnosperms are, on the one hand, most nearly allied in the order of descent to ferns, the sombre flowers which they bear giving them, only by strict botanical classification, a place among phanerogams, they are on the

other hand, more complex in structure than the single seed-leaf plants, because their bark, wood, and pith are clearly defined, as in the double seed-leaf plants. Their lowest representatives comprise the cycads or palm-ferns, so called from their resemblance to palms, for which, with their crown of feathery leaves, they are often mistaken. Next in order is the much more varied and widely distributed conifer family, notably pines, firs and larches, and, lesser in importance, cedars and cypresses. A still higher class, various in its modes of growth, marks the transition to angiosperms, the flowers of both having many features in common.

The single seed-leaf angiosperms have no visible separation of their woody stuff into bark, stem, and pith, and have no rings of growth, the wood exhibiting an even surface, dotted over with small dark points. Their leaves have parallel veins or "nerves," as in the onion and tulip, and the blossom-leaves, or petals, are grouped in threes or multiples of three. Among their several representatives we may single out the lilies for their beauty and fragrance, and the cereals for their value and importance, both classes being in near connexion, since the grasses from which man has developed wheat, barley, oats, rice, and maize are, in a botanical sense, degenerate descendants of the lily family.

The double seed-leaf plants include all the highest and most specialised varieties. Bark, stem, pith, and concentric rings of growth are clearly defined; the leaves are netted-veined, and the petals grouped in fours or fives or multiples of those numbers. The lowest class, represented by the catkin-bearers, as the birch and alder, the poplar and the oak; and by plants allied to the nettle and to the laurel, are nearly related to the highest gymnosperms. Next in order are the crown-bearers, or flowers with corollas, as the rose family, which includes most of our fruit-yielders, from strawberries to apples; while the highest and most perfect of all are plants in which the petals are united together in bell-shape or funnel fashion. Such are the convolvulus and honeysuckle, the olive and ash, and, at the top of the plant-scale, the family of which the daisy is the most familiar representative. Its position among plants corresponds to man's position among animals. As he, in virtue of being the most complex and highly specialised, is at their head, albeit many exceed him in bulk and strength, so is the daisy with its allies, for like reasons, above the giants of the forest.

The primary function for which the organs of plants known as flowers exist is not that which man has long assumed. He once thought that the earth was the centre of the universe, until astronomy dispelled the illusion, and there yet lingers in him an old Adam of conceit that everything on the earth has for its sole end and aim his advantage and service. Evolution will dispel that illusion. But our delight in the colours and perfumes of flowers will not be lessened, while wonder will have larger field for play in learning that the coloured leaves known as flowers, together with their scent and honey, have been developed in furtherance of nature's supreme aim—the preservation and increase of the species. And truly the contrivances to secure this which are manifest in plant-life are astounding, even to those who perceive most clearly the unity of function which connects the highest and lowest life-forms together. It is difficult, nay, well-nigh impossible, to deny the existence of a rudimentary consciousness in the efforts of certain plants to secure fertilisation. Take, for example, the well-known aquatic plant, *Vallisneria spiralis*. When the male flowers detach themselves and float about on the water, the female flowers develop long spiral stalks by which to reach them, and become fertilised by the discharge of pollen on their pistils. Most flowers have their male and female organs within the same petals, and in some cases fertilise themselves by scattering the pollen from the bursting stamens on the stigma or head of the pistil. But nature is opposed to this; "tells us in the most emphatic manner that she abhors perpetual self-fertilisation," with its resultant puny and feeble offspring; and we find a number of contrivances to prevent this, and to secure fertilisation by the pollen of another plant, to the abiding gain all round of the plant, whose blood, as we may say, is thus mixed with that of a stranger. Two agencies—insects and the wind—undesignedly effect this; while in the dispersion of the matured seed, birds and other animals play an important, although equally unconscious, part.

Plants which are wind-fertilised have no gaily-coloured petals or sepals, and do not secrete nectar. Such are the naked-seeded groups whose sombre flowers are borne on dull brown cones; and, among cover-seeded groups, grasses and rushes with their feathery flowers; and willows and birches, with their long waving clusters of catkins. All of these provide against the fitfulness of the wind, which is as likely to blow the pollen one way as another, by producing it in large quantities.

Plants which are insect-fertilised seek to attract their visitors by secreting honey and developing coloured floral organs. The way in which this came about is probably as follows.

The common idea about flowers is that they are made up of petals and sepals, whereas the *essential* parts are the stamens and pistils—i.e. the male, or pollen-producing organs, and the female, or seed-containing organs. The earliest flowers consisted of these alone, having no coloured whorl of petals within another coloured whorl of sepals, but were only scantily protected by leaves, as are many extant species. These the food-seeking insects then, as now, visited for the sake of the pollen, to the detriment of the plant, which lost the fertilising stuff and gained nothing in return. To arrest this, certain plants began, especially when in the act of flowering, to secrete honey and store it in glands or nectaries, or near their seed-vessels, where the insects could not get at it without covering their bodies with some of the pollen, which they rubbed on the pistils of the plant next visited, and thus fertilised the ovule, provided that the plants were nearly related. Honey is sweeter to the taste than pollen, and the plants that produced the most honey stood the better chance of visits from insects, and therefore of fertilisation, to the advantage of their species over others. As a rule, those which secrete honey have hairy coverings at the base of the petals, or other contrivances to prevent it being washed out by the rain or dew, or seized by useless insects, and we find curious interrelations established between plants and their desired visitors. Certain flowers adapt themselves to certain insects, and *vice versâ*, as where the plant has secreted the honey at the bottom of a long tube and the insect has developed a correspondingly long proboscis to gather it. By these and kindred devices the pollen is preserved for its sole function, the energy of the plant being conserved in the smaller quantity which it has to produce. As the honey was secreted as counter-attraction to the pollen, so the coloured floral envelopes were developed to attract the insects to the honey-secreting plant, and those floral whorls, both of petals and sepals, are modified or transformed stamens which have exchanged their function of pollen-producers for that of insect-allurers. And as both stamens and pistils are leaves aborted or modified for the special function of reproduction, Goethe's well-known generalisation that the leaf is the type of the plant has a large measure of truth in it.

But before speaking further about colour-development in plants, it may be useful to say a little about colour itself.

Since everything is black in the dark, and moreover has no colour in itself, it follows that colour is in some way a property of light. Now light, which is itself invisible, is due to vibrations or oscillations set up in all directions by any luminous body—whether the sun or a rushlight—in the ethereal medium which pervades all space, and is composed of rays of different refrangibilities—i.e. change of direction in passing from one medium into another. White light is due to the combination of all these rays, ranging through innumerable gradations of colour from red to violet, and it is to the absence of one or more of them that the infinite variety of colours is due. If a body is quite opaque, or otherwise so constituted as to absorb none of the rays, it appears white; if it absorbs them all it appears black; if it absorbs green, blue and violet, and not red, it appears red; if it absorbs red, orange, and violet, and returns or reflects green, it appears green. The colours which bodies reflect is therefore regulated by their structure; the way in which their molecules are arranged determines the number and character of the light vibrations or ether waves which are returned to the eye and which rule the colour we see—e.g. charcoal and the diamond are both pure carbon; the dull opacity of the one and the trembling splendour of the other are solely due to the arrangement of the several molecules of each.

It is thus obvious that any change in the nature or structure of a thing is accompanied by change in its colour, and to this cause the various pigments in plants is to be referred.

All growth involves expenditure of the energy which the plant has stored within itself, and which becomes active when the hydro-carbons combine with oxygen, resulting in cellular change, and appearance of other colours than the green, which is due to chlorophyll. Thus may be explained the colour of sprouting buds and young shoots and the more or less intensified colours of leaves and flowers—one and all due to oxidation, the minutest changes inducing subtle variations in colour.

Whichever plants made most show of colour would the sooner catch the eye of insects, however dim their perception of the difference in colours might be, and would thus get fertilised before plants which made less display. Thus have insects been the main cause in the propagation of flowering plants; the plants in return developing the colour-sense in insects. The flower nourishes the insect; the insect propagates the flower. Other contrivances to meet the need for fertilisation might be cited, as the markings upon the petals to guide the insect to the nectary; the exhalation of scent by inconspicuous flowers, or by such as would attract visitors at night, and so forth; but enough has been adduced to show what is the chief, if not the sole, function discharged by flowers—the attraction of insects to aid in securing cross-fertilisation. Nor does the provision stop here. The fertilised seed is not left to chance, but, like the fertilising pollen, is entrusted to secondary agents, to the care of the birds and the breezes. Where not scattered by the bursting of the ovary it is winged with gossamer shafts, as in the dandelion, and carried by the wind, floated on gentlest zephyr or rushing storm to a genial soil. Such wind-wafted seeds, like wind-fertilised flowers, are rarely coloured; neither are the seeds of the larger trees, since their abundance ensures notice by food-seeking animals; nor the nuts, which are protected by shelly coats. But other seeds enwrap themselves in sweet pulpy masses, called fruits, whose skins brighten as they ripen, and attract the eye of fruit-loving birds and beasts. The seeds pass through their stomachs undigested, and are scattered by them in their flight over wide areas. As with the brightest-hued and sweetest-scented flowers, so it is with the brightest and juiciest fruits; they sooner attract the visitors whose services they need, and thus gain advantage over less-favoured members of their species, developing by the selective action of their devourers into the finest and pulpiest kinds.

THE VELOCITY OF LIGHT.*

IN one of his early papers on "Optical Recreations" (volume v., p. 351), our contributor, "A Fellow of the Royal Astronomical Society," made cursory reference to the two methods adopted for the determination of the rate at which light travels, and expressed an opinion that the mode devised by Foucault was unquestionably the more trustworthy one. The fine volume before us contains an elaborately detailed description of the most recent application of Foucault's apparatus to the determination of the velocity of light, by Professor Newcomb and Professor Michelson in the United States, during the years 1880, 1881, and 1882; and it has seemed to us that, without encumbering our description with the minutiæ of optical and mechanical ingenuity and of the various corrections applied in reducing the observations, an account of the apparatus employed and of the mode of employing it, by these famous American observers, can scarcely fail to be instructive to all interested in the most refined of all physical measurements.

For the better apprehension of the nature of the work done by the two American professors, it will be better if, in the

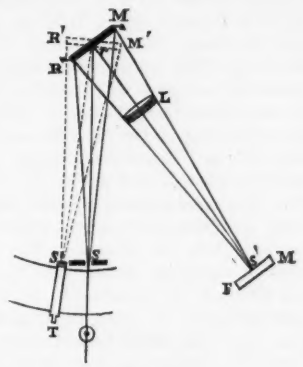

FIG. 1.

outset, we endeavour to render the principle on which their observations were made thoroughly intelligible. To this end we propose to describe the form of apparatus first used by Michelson, being a modification by him of that in which it was originally devised by Foucault; and we shall employ a diagrammatic illustration instead of an actual section or elevation of the arrangement employed, our object being just now to render the principle of the method intelligible. When we come to treat of the shape which the apparatus assumed in the hands of Newcomb, the reader will then be in a position to appreciate the use and significance of the various details. Turn we now to Fig. 1, where we are supposed to be looking down on to the top of Michelson's original form of apparatus. S is a slit with its length square to the surface of this page. Through it, reflected by a heliostat, passes the light from the sun ⊙, and falls upon a mirror R M, which turns round an

* Measures of the Velocity of Light, made under the direction of the Secretary of the Navy, during the years 1880–82, by Simon Newcomb, Professor, U.S. Navy. Vol. II. parts 3 and 4 of the Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac: Washington, 1885.

axis in its own plane (also square to the paper) in the direction of the arrows. L is a long focus lens placed at its own focal distance from R M, and F M a very slightly concave mirror at a considerable distance (say a third of a mile or more) from the revolving one. Let us suppose the revolving mirror to be in the position shown at R M, then a study of the figure will show how the rays from the slit will fall on R M, be by it reflected on to the lens L, and being converged by that lens will form an image of the slit, say at s'. Then the mirror F M is fixed at s', so that its plane shall be at right angles to the axis $r s'$ of the pencil of reflected rays. Now suppose that $r s'$ falls on the lens L, then the light, after passing through the lens, will emerge parallel to r L, fall perpendicularly on F M, and be reflected back by precisely the same route that it came; and if we suppose R M to remain stationary during the interval, the image of the slit S will be reflected on to S itself, and would be in the middle of the field of a telescope placed immediately over S. We have said if R M remains stationary, but we may go farther than this and say that though the mirror R M be rotating rapidly, yet, if during the interval which is occupied by the light in getting from R M to F M and back, R M has not had time to alter its position sensibly, the image of S will equally coincide with the slit S itself. But now let us imagine that the mirror R M is spinning round at such a tremendous rate, in the direction of the arrows, that while it occupies the position R M when the ray starts for F M, by the time that ray gets back it has turned into the position R′ M′, then it will be seen that the image of S will no longer coincide with S itself, but will be reflected to S′, a point somewhere to the left of it (the angle S r S′ being obviously double that through which R M has turned), and if we want to see this image in our telescope we shall have to shift it from its position immediately over S to a new one S′ T. A glance at the figure will show that the distance we have to move our telescope will depend upon the rate at which the mirror is rotating, and on the time occupied by light in travelling from RM to FM and back again. A little very rudimentary mathematics will now enable us to calculate the velocity of light. We measure first SS′ the displacement of the image of S, or the distance through which we have to move our telescope; then the distances S,r and r,s', and finally the number of turns per second that our mirror RM is making. Call SS′,d, Sr = a, r,s' = c. V = the velocity of light; t = time occupied by light in travelling from r to s' and back again. θ = the angle turned through by RM in time t and N = the number of times RM rotates in one second.

In one second RM turns through an angle of 2πN: so that in t seconds it will turn through 2πNt, hence $\theta = 2\pi$Nt.

Now in turning through this angle θ, the mirror has changed the position of the reflected ray from rS to rS′. Therefore the angle SrS′ = 2θ. Further SS′ = Sr tan SrS′ = a tan 2θ. So that S,S′ (our d) = a tan 4πNt. t, though, is the time occupied by the light in going from r to s' and coming back again: whence $t = \frac{2c}{V}$ and $d = a \tan \frac{8\pi Nc}{V}$.

As this angle 2θ is necessarily very small, we may for our purpose use 2θ for tan 2θ, and say $d = \frac{a \times 8\pi Nc}{V}$ or $V = \frac{8\pi Nac}{d}$. In Michelson's original experiments the centre r of the rotating mirror RM was 28·14 feet from the slit S; i.e. a = 28·14 feet. The distance r,s between the centres of the mirrors RM and FM was 661·49 yards; i.e. c = 661·49 yards. The distance SS′ was 4·45 inches: i.e. d = 4·45 inches, and the mirror RM rotated 257 times per second, or N = 257 nearly. If we substitute these quantities in the formula above, we shall find as the resulting velocity of light 184,238 miles per second.

Should the reader fail to grasp the principle of this method, he is earnestly urged to re-peruse, step by step, the explanation given above. When the idea is once grasped, the succeeding description of Professor Newcomb's refined apparatus and methods of observation should present no difficulty whatever.

Let us see what are the essential conditions of construction of the apparatus. First, then, we cannot deal with a ray of ordinary light as a mathematical line, so that a lens, or system of lenses, becomes imperative; and confining ourselves for the time being to a single lens, if we are going to observe a luminous slit, then this slit and the (fixed) concave mirror must be in the conjugate foci of our lens, and the rotating mirror must be in the path of the ray. This lens must, *ex necessitate*, be either between the slit and the revolving mirror, or between the revolving mirror and the distant one. In the former case, however, we are met by the objection that only very small deviations can be accurately measured, as a wide one would send the return ray through a different part of the lens from the out-going ray, and so render measurement very uncertain. Now it must be quite evident that our object is to make the angle to be measured (SrS′ in fig. 1) as large as possible. This means, in practice, that either the slit S, or the fixed concave mirror FM, shall be as far as possible from the rotating mirror. There are numerous objections to removing the slit to any considerable distance, hence in practice it is the fixed mirror which is placed as far as possible from the rotating one. But here again we are met with a difficulty. When the image of the slit is returned and reflected from the rapidly turning mirror, its brilliancy is diminished in the ratio of the diameter of the fixed mirror to the circumference of the circle whose radius is the distance of that mirror from the revolving one. Moreover, in traversing a great distance, reflection, absorption, and dispersion, will all cause further loss of light; so that we require some arrangement that shall render the feeblest return ray visible; in other words we want our field of view as dark as possible.

Now the first device employed by Professor Newcomb for this purpose was to employ two telescopes—one for sending the ray out, and the other for receiving the return flash. In order that the two reflections, however, should take place from the same part of the rotating mirror, these two telescopes would require to be in the same horizontal plane. But it is abundantly obvious that no small deviations could possibly have been measured with this arrangement, as the two telescopes would have been in one another's way. It was, moreover, found that, in addition to this drawback, the quantity of light irregularly reflected from the mirror when the sun shone upon it inconveniently illuminated the field of view. Hence the telescopes were placed one above another, and the mirror elongated sufficiently to receive the rays from each telescope. As we shall presently see, the rotating mirror was capable of being turned in either direction, so that measurements of deviation could be made, so to speak, both to the right and left of the slit. Hence all uncertainty as to measurement from a zero point was eliminated. Reverting now to the subject of the darkening of the field of view so as to render the faint reflected image of the slit conspicuous, we may briefly say that the whole apparatus was contained in a dark room in which there were only two openings, one for admitting the light from the heliostat to the slit, and the second for sending and receiving the reflected light. This light came through a small opening in a blackened box some fifty yards distant in the path of the ray. The result of the whole arrangement was that just enough diffused light entered the receiving telescope to

render the spider line in the eye-piece visible. Bright wires would have been needed with any fainter light than this. The rotating mirror was most ingenious, and Professor Newcomb expresses his obligation to Professor H. A. Rowland, of Baltimore, for the valuable aid he rendered in devising it. It consisted of a solid rectangular steel prism with carefully ground and polished sides. To the top and bottom of this were fastened pairs of circular plates, each pair holding a set of twelve fans, upon which an air-blast impinged. The top and bottom of the axes of the mirror terminated in slightly conical pivots, the surface of the bottom one being very nearly flat and about ·08 inch in diameter. This rested on a diamond. By an elaborate system of air-pipes the observer could cause this mirror to rotate either to the right or to the left, and by opening slightly the bottom apertures, when the air-blast rotating the mirror was entering by the top set, and *vice versâ*, could regulate the rate of its motion to a nicety. The number of complete rotations performed in a second was measured by fixing a pinion of sixteen teeth round the upper axis of the mirror. This geared into a wheel with sixty-four teeth, as did that, in turn, by a ten-tooth pinion into a wheel of seventy teeth, so that the latter turned once for every twenty-eight times that the mirror did. A knob in this last wheel at every revolution touched a spring which formed part of an electric circuit passing through a standard, so that circuit was broken once in every twenty-eight turns of the mirror. A cylinder chronograph was caused to perform one revolution in ten seconds. Its pen was connected with a closed circuit, passing through a break-circuit chronometer and through the spring just spoken of. Thus two series of indentations appeared in the line marked by the pen on the chronograph, the one at intervals of a second and the other at the intervals in which the mirror performed twenty-eight revolutions. A curious thing happened in connection with this recording apparatus. After a few days' trial it was found that the wheel work was entirely destroyed by the rapid rotation to which it was subjected. New wheels wore out before it was practicable to obtain a set of readings! In this extremity Professor Newcomb returned the apparatus to its makers, Messrs. Clark and Sons, and they hit upon the ingenious device of employing raw hide for the first wheel, with entire success. The position of the receiving telescope was read off upon an arc, whose centre lay in the prolongation of the vertical axis of the rotating mirror, such reading being made by suitable reading microscopes attached to the horizontal frame carrying the receiving telescope. The eye-end of the telescope itself carried a micrometer. A little thought will suffice to show that, as the transmitting telescope must send its rays approximately in the same direction as that from which they are received, if the two telescopes were directly over each other the slit end of the transmitting one would be right in the way of the observer. This difficulty was overcome by the simple expedient of bending the transmitting telescope at a right angle, and putting a diagonal mirror at the bend to reflect the light from the slit through the object-glass. All this will be rendered intelligible by reference to fig. 2.

F is the sending telescope. The light of the sun is sent by a heliostat through the slit S, passes down the tube and is reflected by the diagonal mirror through the object-glass J. *m* is the revolving mirror receiving this light and reflecting it along Z to the distant fixed mirror (not shown). M,M,M,M a stiff frame screwed into stone caps on the brick piers P,P′ with a horizontal divided arc on it at A. L the receiving telescope with its objective immediately below J, mounted on adjustable Y's on the frame N which turns horizontally round a vertical axis coincident with that of *m*. Its extreme range of motion is about 8°. The apparatus through which the air-blasts pass to turn the mirror *m* is omitted, as it is somewhat too complicated to be shown on the small scale of our drawing.

The measurements were performed by Professors Newcomb and Michelson, and by Ensign Holcombe, U.S.N. The stations were selected on the opposite sides of the Potomac river; the telescopes and rotating mirror being erected in Fort Myer, on the Virginia side of the river, overlooking the city of Washington. In the first instance the fixed mirror was placed in the grounds of the Naval Observatory; but, it being subsequently found that observations could be made at a greater distance, this mirror was removed to a point at the base of the Washington Monument. In the first case the total distance between the mirrors was 1·585

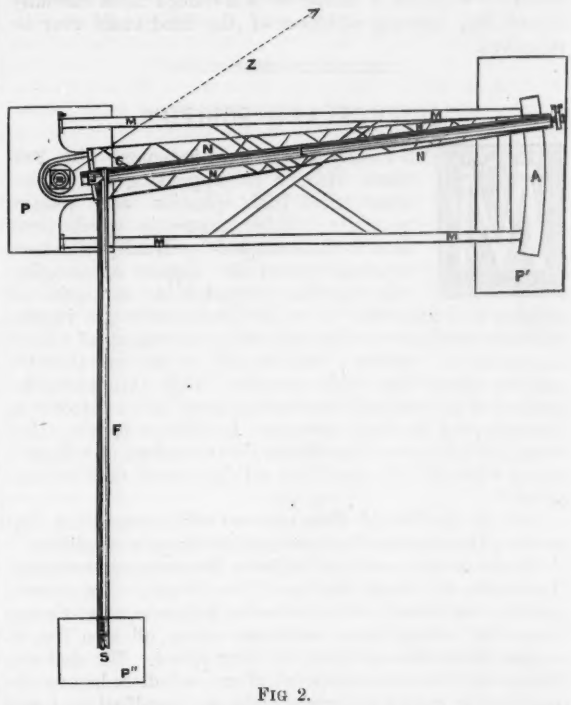

FIG 2.

mile; in the second 2·312 miles; the light, going and returning, of course, travelling over double these distances respectively. What we have called the fixed mirror was really two mirrors of 15¾ inches in diameter, placed side by side. Their radius of curvature was something like 1·86 mile.

As the result of a most elaborate and exhaustive series of observations with this beautiful apparatus, Professor Newcomb finally deduced as the velocity of light in vacuo 186,326±25 miles per second. It will interest the astronomer to derive the solar parallax from this determination, in combination with the now generally accepted constant of aberration (that of Nyrén) 20″·492, and Colonel Clarke's computed equatorial radius of the earth, 3963·296 miles. It will be found to be 8″·794, corresponding to a mean distance of the earth from the sun of 92,959,200 miles.

At Professor Newcomb's request, Professor Michelson subsequently repeated his own determination of the velocity of light by the method originally employed by him. As a final result he obtained 186,322±37 miles per second as the rate at which light travels in vacuo, an approximation surprisingly close to that of Professor Newcomb, when we

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consider the extraordinarily delicate character of the investigation. Moreover, Professors Newcomb and Michelson in the course of their most recent series of observations, were enabled to set at rest a curious discussion started in 1880–81 by Professors Young and Forbes; who, employing a modification of Fizeau's toothed-wheeled apparatus, got the fancy into their heads that light of different refrangibilities (or colours) travelled at different rates. Were this true, of course a star like Algol would show marked chromatic phenomena during its increase and decrease, which it notoriously does not. Also a well marked iridescence of the edges of the return image of the slit must be perceptible in the apparatus which we have been endeavouring to describe; while as a matter of fact, though most carefully looked for, nothing whatever of the kind could ever be perceived.

SCIENCE AND POLITICS.

MANY daily papers were indignant with Professor Huxley for expressing an opinion about the Irish question and politics generally. Other papers in which views akin to those adopted by Huxley have been expressed found his support encouraging, and therefore regarded his expression of opinion with approval. It might be interesting to inquire whether the former really objected to a student of science expressing an opinion *at all*, or only to the fact that the opinion about the Irish question which this particular student of science had expressed chanced to be adverse to that adopted in their columns. Be this as it may, they definitely laid down the opinion that a student of science is going "outside his depth" in talking about such matters at all.

Let us consider if there are any valid reasons for thus putting the student of science outside the pale of politics.

In our country we have in theory democratic government. In practice the theory may be a little diluted. Yet even in practice we find all classes possessing influence, almost every man who has any stake whatever voting, all men free to express their views as loudly as they please. We find our House of Commons composed of men of all orders in the community, except clergymen, who are manifestly not well fitted for political life. If a man who has passed all his life in banking business, or in legal practice, or in manufacture, trade, or commerce, takes it into his head to seek for admission into Parliament, no one proclaims that he is "out of his depth" in talking about political matters, though mere election to the House of Commons is not an equivalent for political education. But outside Parliament, men whose lives have been passed in pursuits in no way connected with politics are listened to with attention. Is there anything in the study of science which should prevent a man from forming a just opinion on political matters, any more than there is in the study of the money market and City intelligence?

It may be urged, perhaps, that men of science are very apt to be, or to appear, so engrossed in their own special and appropriate pursuits, that they seem to care little about political matters. But it ought to be regarded as at least possible that in this customary silence about matters in regard to which the most ignorant and foolish are always ready to proclaim their contradictory notions, the student of science shows not only more sense, but even that he has studied political matters more closely than the noisy herd who are always talking about them.

As a mere matter of fact, nothing seems to the student of science much more absurd than the careless haste with which the average mind proclaims its views on matters of the profoundest difficulty. It appears to matter nothing to Tom, Dick, and Harry that they know nothing or less than nothing (for wrong ideas are worse than none) about a political question which troubles the country and perplexes the most thoughtful minds and the most carefully trained politicians. Tom is not concerned because Dick differs from him, or because Harry agrees with neither. Nor are any of the three, or the classes they represent, troubled because in former times they expressed quite different views, or because their actual views, the product of a day, are likely to last but for an hour. They are as dogmatic and as positive as if they had absolute certainty, where in reality their ideas have no more stability than the waves of a storm-tossed sea.

And this applies to the average body in Parliament as well as to the average body in the community. It appears to outsiders as if members of Parliament were devoting so much time and attention to legislative and political matters that they must necessarily be fitter to decide about matters affecting the community and the nation than those who elected them and sent them to work for them (as they suppose). But about the only matters in which the average member of Parliament is more experienced than the average merchant or tradesman are those relating to Parliamentary procedure, and there is nothing in these by which statesmanship or legislative skill may be fostered. Indeed, it is commonly noted that those members of Parliament who are sharpest about matters of procedure are the least capable in regard to higher matters.

Now, the student of science has at least one immense advantage over average men whose avocations are unscientific. His training requires that he should constantly consider cause and effect, the action and operation of law. It is here that your average politician, and many, indeed, who are somewhat above the average, are weakest. They are always being led astray by the mistake of confounding mere sequence with causal influence, or, in technical terms, they are constantly misled by the *post hoc ergo propter hoc* fallacy. Nine-tenths of the legislation of the present reign, for instance, has been affected by this fallacy, as its consequences have shown. The very multiplicity of the law-making experiences of our Parliaments attests the blundering capabilities of our legislators; for nine-tenths of their work is directed to the repairing of previous mistakes.

Then, again, there is another most important advantage which the mind trained in scientific pursuits has over minds otherwise exercised. The student of science is constantly taught the necessity of cautious and repeated inquiries into the validity of evidence or of reasoning which to the unscientific mind would appear absolutely and overwhelmingly decisive. We have only to compare the student of science of to-day with his predecessor in past ages to see how wonderfully scientific caution has developed, even while scientific daring has increased in as marvellous degree.

In old times men calmly advanced such explanations as the more obvious evidence seemed to them to suggest, and seem never to have been troubled with a trace of doubt. If rain fell, "the floodgates of heaven" had been "opened"; if the sun rules the seasons, and the moon measures time, the sun and moon were made—and the stars also—to *be* for signs and seasons, and for days and years; if the hare seems to work its lips like a ruminating animal, the hare is immediately classed among creatures which chew the cud; and so with a hundred seemingly obvious facts which are now known to be perfectly obvious blunders. But now the student of science—who, if he is wise, no longer calls himself a man of science—questions all that seems most

obvious, doubts even all theories which seem most thoroughly established. The rain which seems to come from the skies, which had been traced to the clouds, and thence to unseen pure transparent vapour, he traces yet farther back by circuitous aerial courses to other regions, and thence to the sea, while he finds as the actual cause of rain that which to the ancients seemed the great opponent of rain, the destroyer of the clouds—the might and glory of the sun. And so, in all matters which the man of science of old explained simply and easily, the modern student of science weighs and balances and doubts, till at last he is able to show *how*, but modestly admits that he cannot explain *why*, the so simply explained because so thoroughly misunderstood phenomena take place.

Now, neither the constant study of cause and effect in physical or mental phenomena, nor the development of a habit of most cautiously dealing with all evidence obtainable, can fit the student of science to express an opinion on some political or legislative matter into which he has not made careful and special inquiry. If a Darwin or a Newton, departing from his natural or acquired character, were to undertake to decide on a point of statesmanship or of religion, in which he admitted that he had taken no special interest, and about which he had made no investigations, his opinion would deserve no more respect (but, be it noticed, it would deserve no less) than that of a merchant or a landowner, who had managed to get into Parliament, and had there supplemented his commercial or agricultural experience by more or less careful study of Parliamentary procedure. The former would be forgetting the lessons of his scientific life, forsaking the advantage of his scientific training—and would, almost certainly, fall into some gross blunder. But the latter is falling into such blunders all the time; and the student of science is among the innocent members of the social body who have to pay for such blundering—and a tolerably heavy price we pay, too.

If a man of approved scientific powers, however, trained to cautious study of carefully accumulated evidence, speaks about a political or a religious matter with some degree of confidence, it may be usually taken for granted that he *has* given the matter careful attention—simply because it would be running counter to the whole spirit of his career to speak in that manner of a matter that he had not studied. For this reason, I should myself attach very much greater weight to the definitely expressed opinion of a Tyndall or a Stokes, a Huxley or a Spencer—of any scientific man, in fact, *not* a specialist (specialists being mostly narrow-minded)—about any political or religious matter, than I would to the opinion of a politician or a priest. For while I should feel well assured that the man of science must have studied the subject or he would not speak about it (the chances being rather the other way with the politician and the priest), I should know that his study of the subject, checked by the scientific habit of cautious and law-seeking inquiry, would be bound to be much more satisfactory than that made by men less cognisant of the necessity for studying causal relations and for exercising constant caution.

Unfortunately, students of science very seldom do express an opinion about political or religious matters—which is another way of saying that they seldom make political or religious matters the subject of inquiry. When they do, the unscientific necessarily imagine they are going beyond their depth. But in reality, the student of science recognises how thoroughly the ordinary politician goes outside his depth in nearly all that he undertakes to discuss or deal with. Mr. Herbert Spencer has well shown in the introductory pages of his "Sociology" the absurdity of the calm security, the overweening self-confidence, with which the average politician (who generally knows nothing about politics beyond its vocabulary—which is naught) undertakes to make and alter laws for regulating relations far more complex than those with which the student of science ordinarily deals.

As for Professor Huxley's remarks, if he was out of his depth in making them, it must be assumed that the student of science may only enter very shallow waters indeed. This is by no means saying that I agree with him (it chances, indeed, that I do not), only that I think he has at least as good a right to form and formulate an opinion as the average member of Parliament, or even the editors of the daily papers and the "young buccaneers of the press" over whom they hold command. Any one who knows how and by whom newspaper articles are written must smile at the weight which the average reader of newspapers attaches to their trivial utterances. Even as one who has studied our universities smiles when he sees men and women—aye, the aged and experienced—moved by the commonplace teachings of men who till a year or so before had "vexed the souls of deans" (and barely escaped plucking in mild examinations because of their undue devotion to boating and cricket, cards and billiards), so must we smile, though with a touch of sadness, to see the business men of a nation accepting the political teachings of half-fledged youngsters, failures in their selected professions, writing at the order of men who know even less than themselves about politics or statecraft. Yet the confident air of these weaklings, the energy of their assumed enthusiasm, and the violence of their party zeal, produce far more impression on the many than the well-weighed and therefore cautious opinions of the thoughtful student of political and sociological history.

Professor Huxley has simply pointed out that our leading politicians ought to lead, not to be led; that trying to find out what is the average opinion of the nation, the opinion held by the greatest number not by the best quality, and then following that opinion, is a course likely to result in no great achievements. He has expressed admiration for Mr. Parnell as leading, not being led, but not for Mr. Parnell's views—the success of which, he thinks, will be Mr. Parnell's ruin. And if he has expressed his objection to Home Rule, in which certainly he is not particularly original, he is modest enough in his ideas not to point out the course along which he would like to see some statesman guiding the country.

But to some half-trained leader-writer in a daily paper, who would treat with respect the utterances of a man whose whole life had been passed in huckstering on a rather large scale, the opinion of a keen and earnest thinker, trained to careful reasoning and to caution in forming an opinion, appears—so ignorant is he—as floundering no worthier of respect than he knows his own ideas to be.

In this country, as in America, we need the well-weighed thoughts of the minds which recognise law and causation; we have long had much more than enough of the utterances of those who recognise only luck and sequence, whose legislative measures have as much real relation to the needs of the nation as the thrice turning of a gambler's chair or a change of the pack he plays with has to the success of his play.—*Newcastle Weekly Chronicle.*

APPROACHING EXTINCTION OF THE LION.—When we hear that the lion of the desert is threatened with extinction, we cannot regret the circumstance, king though he be of animals. Sportsmen and zoologists may lament, but others cannot, when we hear that the Government of Algeria is paying a high premium (2*l.* a head) for lions killed in that country, and that within the last eleven years a sum of 400*l.* has been paid in this way, telling of 200 lions destroyed. The lion of the desert is, in fact, becoming a thing of the past.—*Newcastle Weekly Chronicle.*

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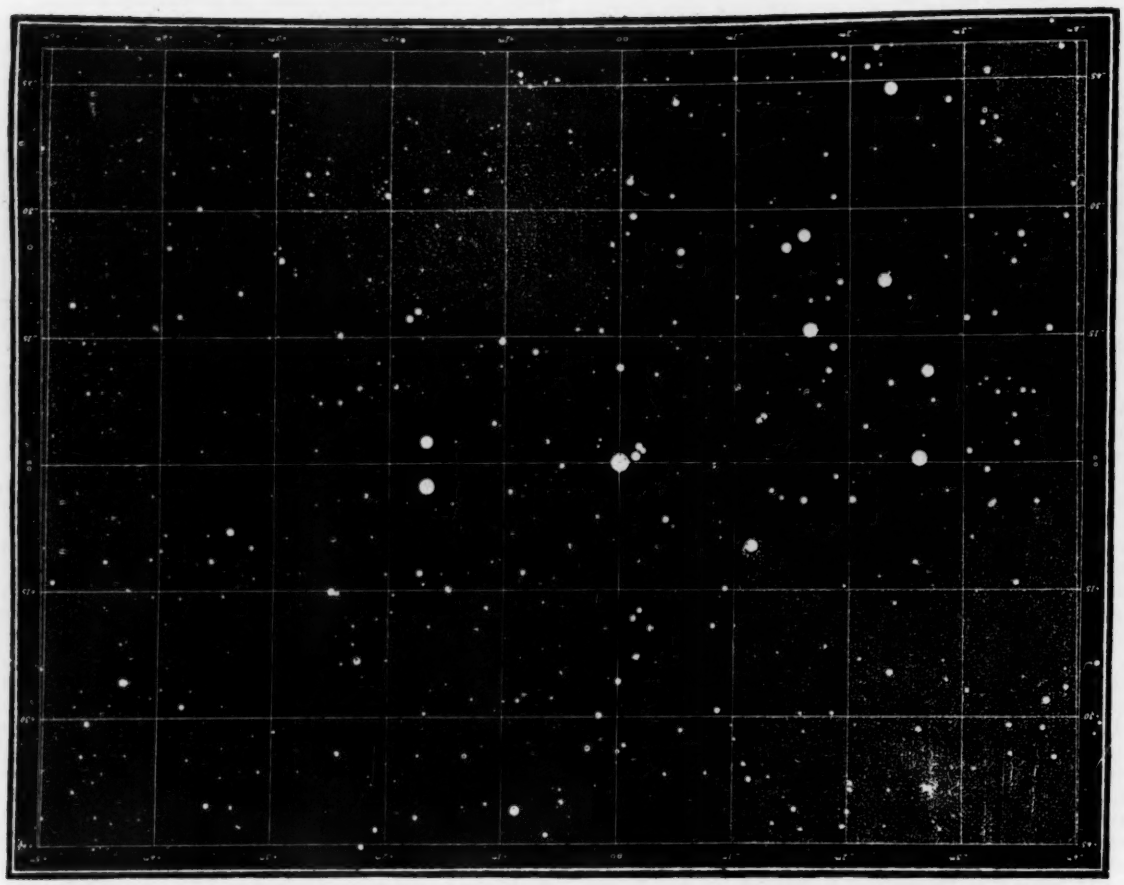

FIG. 1.—CHART OF THE PLEIADES, DRAWN BY M. WOLF IN 1874, AT THE PARIS OBSERVATORY.
(This chart, prepared for the observatory, is here purposely inverted to show the Pleiades as presented in the small chart, fig. 3.)

FIG. 2.—PHOTOGRAPH OF THE PLEIADES, BY THE BROTHERS HENRY.
Three Exposures, each of one hour.

THE PLEIADES PHOTOGRAPHED.

THE accompanying views of the Pleiades enable us to compare the work of the telescope and the human eye (fig. 1) with the work of the photographic eye (fig. 2).

In fig. 1, the star Alcyone is taken as the central point from which ascension and declination are measured, the plus sign indicating, of course, declination north of Alcyone and increase of right ascension. One of the nebulosities in this map extends from Merope southwards and westwards, and around the Pleiades northwards. The other extends northwards from Pleione. But although M. Wolf, to whom this map is due, indicates this enormous extension of both nebulosities, there is in truth little authority for it.

In fig. 2, we have the result of photography alone. The nebulosity from Merope is shown with much less extension than in fig. 1, but with indications of detail such as M. Wolf's drawing does not present. The chief interest of this photographic view, however, resides in the nebulous extension from Maia, which had never been detected by human eye.

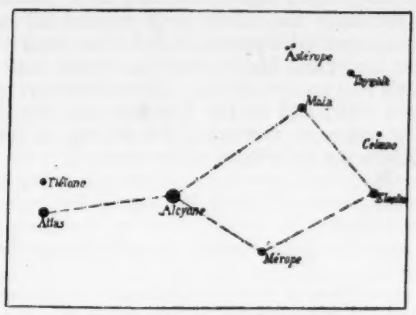

FIG. 3.—CHART OF THE NINE CHIEF STARS OF THE PLEIADES CLUSTER.

Fig. 3 is added to enable the student to identify the leading stars of the group. All three figures are from M. Flammarion's *Revue d'Astronomie*.

Next month we propose to consider the significance of the nebulosities in the Pleiades, as throwing important light on the structure of the stellar universe. An enlarged view of the nebula around Maia will then be given.

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INDIAN MYTHS.

By "Stella Occidens."

> . . . slow, ascending one by one,
> The kindling constellations shone.
> Begirt with many a blazing star,
> Stood the great giant Algebar,
> Orion, hunter of the beast!
> His sword hung gleaming by his side,
> And, on his arm the lion's hide
> Scattered across the midnight air
> The golden radiance of its hair.
>
> Longfellow.

WE have become acquainted with some of the Indian Myths about the sun, the moon, and the Milky Way, and now we must turn our attention to the constellations. These groupings of brilliant stars suggested to the vivid imagination of the Indian many fanciful stories, which, however, are not as superficial as they may appear. If we could understand their thoughts we could trace some reason for these myths, which are founded on the everyday experiences of these savage races. According to the Iroquois traditions the stars were supposed to be the souls of departed warriors, or favoured animals and birds. The constellations were thought to be groups of especially favoured mortals, the constellation Orion being that of an intrepid hunter of enormous size. The Eskimos believe that the stars in his belt are seal-hunters who missed their way, and they call them the Lost Ones. The Iroquois believe that these bright stars are brothers, who left their home, where they had been badly treated. They were pursued by their parents, who have been ceaselessly chasing them.*

The Iroquois tribe have an interesting story with regard to the group of stars known as the Pleiades, or Dancers. They believe that it is a group of seven little Indian boys. The latter were in the habit of eating their supper of corn and beans every evening on a little mound. After they had eaten, the sweetest singer would sit on the top of the mound and sing for his playmates, whilst they would dance around him. One day they resolved to have a great feast, but unfortunately the parents refused to supply the food, so the seven little Indians resolved to have a feastless dance. As they flew round the mound to the sweet, enchanting strains of the singer, their heads and their hearts grew lighter. Suddenly the whole party whirled off into the air, and the inconsolable parents called after them in vain. They arose higher and higher, whirling around their singer until at last they reached the sky. Here they were changed into bright stars, and as the Pleiades they are dancing still. The singer, on account of his desiring to return to the earth, was not as brilliant as the rest.†

In the Northern hemisphere there is a group of stars which the Odjibwas call Ojeeg Annung, or the Fisher stars. They are supposed to be the same as the group of the Plough, and the following tale is related respecting this constellation:—

Once there lived a celebrated hunter on the shores of Lake Superior who was so successful in the chase that he was considered by some to be a Manito. His name was Ojeeg Annung, or the Fisher, and was that of a sprightly little animal common in that region. He lived in a wild, lonely wood with his wife and his little son. The latter wished to be a great hunter like his father, and tried his skill on birds and squirrels. The only difficulty in his way was the extreme cold; his little hands would often be frostbitten, and he would run home complaining to his mother. One day, when he was returning with a heavy heart, he saw a small red squirrel gnawing the top of a pine bur. He approached near enough to shoot him, when the squirrel sat up on his hind legs and thus addressed him:—

"My grandchild, put up your arrows, and listen to what I have to tell you." The boy obeyed somewhat reluctantly, and the squirrel gave him the following advice. He promised the boy perpetual summer and the pleasure of killing as many birds as he pleased if he would do as he directed. He told the boy to cry bitterly, and complain of the cold when he reached home and refuse to eat anything. "This will naturally arouse your father's curiosity, who will ask the cause of your grief. Tell him, then, that seeing the snow always on the ground troubles you, and ask him if he is not powerful enough to make it perpetual summer. He will tell you to be still, and cease crying, and he will try to bring summer for you. You must then be quiet, and eat what is placed before you."

The boy did as he was told, and all came true. The father had a great feast, to which he invited some of his friends, who then accompanied him on his journey. After twenty days they arrived at the foot of a high mountain; here they followed a track which led them to a hollow in the mountain. Ojeeg warned his friends not to laugh on any account, for they were about to see the great Manito, who was deformed. His head was enormously large; he had a queer set of teeth, and no arms, and his movements were so awkward that the Otter laughed as soon as he saw him. The Manito sprang at him, but the Otter escaped, and was soon rejoined by his friends, who had brought some meat for him.

When the party reached the top of the mountain they were very high up, and they all made attempts to try and make a hole in the sky.

All failed except Wolverine, who after the third attempt succeeded in making a hole, and the Fisher quickly followed.

They found themselves in a beautiful plain, and the trees were alive with birds of different plumage, warbling their sweet notes, and delighted with perpetual spring. Fisher, seeing some birds in cages, let them out, and they escaped through the opening in the sky. When the celestial inhabitants saw the birds let loose, and the warm gales descending on the earth, they ran to their lodges. It was too late. Spring, summer, and autumn had gone; even perpetual summer had almost gone. They separated it with a blow, and only a part descended. Wolverine, hearing the noise, escaped through the hole in the sky; but the Fisher was too late, and, being pursued, he was hit at last by an arrow near the tip of his tail. This was the only vulnerable spot in his body, and, after a vain attempt to descend to earth, he laid himself down to die. He said: "I have fulfilled my promise to my son, though it cost me my life; but I die satisfied in the idea that I have done so much good, not only for him, but for my fellow-beings. Hereafter I will be a sign to the inhabitants of the earth, who will venerate my name for having succeeded in procuring the varying seasons. They will now have from eight to ten months without snow."

Next morning he was found dead with the arrow sticking in his tail, as it can be plainly seen at this time, in the heavens.*

The constellation of the Great Bear has given rise to curious myths. Flammarion, in his "Astronomical Myths," in the chapter on the origin of constellations, remarks that "the Iroquois, when America was discovered, called it Okouari, their name for a bear. The explanation of this

* "Myths and Dreams." Clodd, p. 30.

† "Bureau of Ethnology," 1880–81, p. 80. Smithsonian Institute.

* Schoolcraft, "Hiawatha Legends," p. 121.

name is certainly not to be found in the resemblance of the constellation to the animal."* The Iroquois tradition, however, accounts for its name in the following way: "A party of hunters were once in pursuit of a bear, when they were attacked by a monster stone giant, and all but three destroyed. The three, together with the bear, were carried by invisible spirits up into the sky, where the bear can still be seen, pursued by the first hunter with his bow, the second who bears a kettle, and the third, who, farther behind, is gathering sticks. Only in the fall do the arrows of the hunter pierce the bear, when his dripping blood tinges the autumn foliage. Then for a time he is invisible, but afterwards reappears." †

This same belief existed among the Algonquin Indians of New England, and is related in a poem, of which the following is a translation:

We are the stars which sing,
We sing with our light;
We are the birds of fire,
We fly over the sky.
Our light is a voice;
We make a road for spirits,
For the spirits to pass over.
Among us are three hunters
Who chase a bear;
There never was a time
When they were not hunting,
We look down on the mountains.
This is the Song of the Stars. ‡

DID BIRDS OR BEASTS COME FIRST?

NOTE RESPECTING CERTAIN AFFIRMATIONS, ANCIENT AND RECENT, CONCERNING THE QUESTION OF MAMMALIAN JUNIORITY.

BY OSWALD DAWSON.

IN the March issue of KNOWLEDGE, Mr. Edward Clodd is printed as affirming that birds "certainly preceded mammals in the succession of species." As it happens that the claims to seniority of the air-population and land-population has been a topic of extreme interest throughout England and elsewhere since the publication of Mr. Gladstone's "Dawn of Creation and of Worship" in the *Nineteenth Century* of last November, and since Prof. Huxley allowed Mr. Gladstone's statement that the juniority of mammals was a "demonstrated conclusion and established fact" to pass unchallenged, § I shall presume to question this alleged "certainty."

When finding Prof. H. G. Seeley affirm that "geological history does not carry us back appreciably towards the origin of the great divisions of organic nature—there is evolution, but it is only the evolution of genera and of ordinal groups and not of classes" (pp. 451, 526, of "Manual of Geology"), one is tempted to suppose that considerations other than those derived from palæontology have prompted Mr. Clodd's declaration. Yet what can such considerations be? No one imagines that the *Monotremata* are indebted for their ornithic or sauropsidan characters to inheritance from birds. Birds are not more highly organised than mammals, thus favouring a presumption that their evolution must have commenced earlier. More multitudinous in specific forms than mammals birds may be, but did this indicate a higher antiquity, its weight would speedily be more than neutralised by a reference to the notorious homogeneity of the class *Aves* in comparison with the class *Mammalia*, or, indeed, with the *Ungulata*, e.g., alone.

Mr. Clodd makes the singular remark that, "in the absence of proof that" certain Triassic footprints "are due to birds, which certainly preceded mammals in the succession of species, a great link is missing in the Trias, since that system has yielded teeth of the earliest known mammal." Truly "a great link is missing," if what is sought be an iota of warrant for the assumption that birds certainly preceded mammals; but otherwise no link, great or small, is missing. Even were the Connecticut prints proven to be avian, the seniority of birds would only be established by assuming that the beasts of the upper Trias exhibited to us the dawn of mammalian life, and then the seniority would be won by less than a period. But it is generally admitted that the *Monotremata* are the nearest representatives of the primordial *Mammalia*, justifying Professor Huxley's designation of *Prototheria*;* whereas *Microlestes* &c. are affiliated to one or other of the Marsupial, or, it may be, Eutherian groups.

The post-Amphibian ancestors of the *Mammalia* are not known. They are termed *Hypotheria*. Though the Thuringian lizard of the Permian occupies an exalted position in Professor Haeckel's "Twenty-two Ancestral Stages of Man," and though we have "theriodont" and otherwise theriomorphic fossil reptiles, it nevertheless remains improbable that any reptile has intruded into mammalian phylogeny. But even were the contrary view proven, a post-Palæozoic origin of mammals would by no means be involved in the circumstance. I commend those who fancy otherwise to Prof. Huxley's criticism of Prof. Haeckel's "Ante-Triassic" &c. periods ("Critiques and Addresses," pp. 310–312). The illustrious critic would "put the existence of the common stock" of reptiles "far back in the Palæozoic epoch;" and, having mentioned that "*Mammalia* certainly" existed in the Triassic age, concludes with the sound remark: "I should apply a similar argumentation to all other groups of animals" besides reptiles. Prof. Flower, too, finds it "reasonable to conclude" that *Prototheria*, *Metatheria*, "*and perhaps* Eutheria" existed "*far back in the Mesozoic age*" ("Osteology of the Mammalia," third ed., p. 5). One of the latest authorities, or, at any rate, authors, the late Prof. Oscar Schmidt, in his "Mammalia in their relation to Primæval Times," gives us no clue as to the relation of the *Prototheria* to primeval times. This writer (on p. 253) states that "the vertebræ of whales have even been found in the Jura." † Additional evidence could be cited, were it needful, to justify a belief in the antiquity of beasts.

However, the *Hypotheria* were, almost certainly, possessed of two occipital condyles, in common with *Amphibia* and *Mammalia*. And in any case, in order to establish the certainty of priority of birds over beasts, we must assume that the *Prototheria* were evolved from the *Hypotheria*, and then gave rise to the marsupials (or insectivora?) in the interval of time between the depositions of the lower and upper Trias (again assuming that the Connecticut

* Flammarion, "Astronomical Myths," p. 61. [The resemblance, however, is far stronger than can be recognised in the case of most constellations, if it be sought in the right way. There is certainly no long-tailed bear in the sky, but neither is there in nature.—R. P.]

† "Bureau of Ethnology," 1880–81, p. 80. Smithsonian Institute.

‡ Algonquin, "Legends of New England," p. 379. Leland.

§ Unless his remark that "the question of the exact meaning of 'higher' and 'ordinary' in the case of mammals opens up the prospect of a hopeful logomachy" be capable of interpretation as a challenge.

* I presume they would retain this title even should the marsupials be proved to be not intermediate between them and the *Eutheria*. Cf. George J. Romanes in the *Fortnightly Review* (p. 336, footnote), March 1886.

† I may here notice a curious misprint, which makes Mr. Clodd affirm that "whales" are abundant in the Trias.

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prints are avian); or we must assume that, the above-mentioned transformations having occurred partly in Palæozoic times, the passage from reptile to bird was effected during a yet earlier period of that epoch. The former is a gratuitous and needless, even if it be not a preposterous assumption; while, as regards the latter, attention must be drawn to the reptilian character of the Mesozoic birds; how in the Trias we find them addicted to quadrupedal habits; in the Jurassic, using the claws of their anterior extremities (probably) for "catching hold"; here but partially or not at all feathered, there well arrayed with teeth, and so on; everywhere, in brief, announcing themselves as undergoing a contemporary evolution.

In fine, if "certainly" be a fit expression to employ in dealing with a subject about which an authority like Prof. Seeley is so little sanguine, it would be preferable to summon it *after reversing* the order of succession announced by the authors of the "Story of Creation," as given in the first chapter of the Pentateuch, and the March issue of KNOWLEDGE.

PLEASANT HOURS WITH THE MICROSCOPE.

By Henry J. Slack, F.G.S., F.R.M.S.

THE biting and chewing organ of rotifers is commonly called a gizzard, but it does not correspond with the grinding machine of the fowl, or with the remarkable one of the house cricket or the coarser one of the blackbeetle. It is, as Gosse showed many years ago, a mouth, having certain resemblances to the trophi, or mouth organs, of insects, which are composed in the well-developed instances of beetles of two mandibles, or chief jaws, two maxillæ, or lesser jaws, and an upper and lower lip. If the student will examine these parts in a biting beetle, and then look at the mouth apparatus of a gnat, a flea, a bug, a butterfly, and a bluebottle, the first impression will be that each one belongs to an entirely different plan. The beetle is evidently a biter with cutting and tearing forceps. It can *bite* a hole in a hard substance, but has no boring or piercing tool and no saw. The flea has exquisite saws; the bug, three very fine lancets and a sucking tube. The gnat is not a biter; she—for the female is the tormenting one—possesses six sharp-pointed lancets, two of which (the maxillæ) have some sawlike teeth at the top. There is also a long, stout, cylindrical piece ending in a cleft knob, like the opening bud of a flower. All these parts can be traced as modifications of the corresponding parts of the mouth of a biting beetle. The stout long cylinder is an immense prolongation of the lower lip (labium), the lancets are modifications of the mandibles and maxillæ, and so on. The bluebottle's mouth is formed as a sucking machine of another type. It is remarkable for a number of partially open tubes—modified tracheæ—and this sort of construction is carried to a wonderful extent in the Daddy Longlegs gnat, which has over three hundred of them.

Speaking generally, when any organ shows a capability of considerable modification, some species of creature is sure to exist in which the modified organ is so widely different from the simplest form in which it is known that the resemblance (homology) can only be traced by studying the intermediate gradations.

The rotifer's mouth, which can only be thrust out in some species, is a biting and chewing machine, exhibited by the pitcher rotifers, or *Brachions*, in the greatest perfection. Let us examine one of them with Mr. Gosse's assistance. First there is a globular bag which contains and moves the various parts by means of appropriate muscles. There we find the parts shown in the annexed view (fig. 1), borrowed from Gosse. The muscular bag *a* he calls a *mastax*, which means mouth or jaws; *b* is a com-

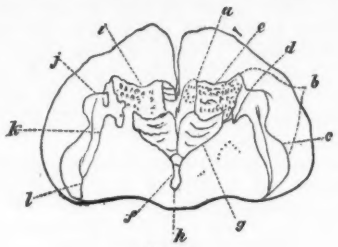

Fig. 1.

plex piece, the *malleus* or hammer; *c*, its handle (*manubrium*); at *d* is a joint articulating the handle to *e*, the *uncus* or hook; *f* is another complex piece, forming the *incus* or anvil, being the part on which the hammers strike; *g* (lettered only on one side) represents two pieces—*rami*, or branches—hinged on to *h*, the fulcrum, so as to open and shut. The motions of all these parts when in action are very complicated. What may be called the toothed or ribbed heads of the hammers come together and fall on the corresponding parts of the anvil, which has its own motions. This wonderful organ can exercise some choice, and if an impracticable or unfit substance gets in the handles give a sudden twist and toss it out.

In watching the proceedings of a pitcher rotifer we never witness the amount of chewing that might be expected from the complexity of the machine. Most of the objects swallowed pass into the stomach after a few grips which do not pulp them, and often do not alter their appearance.

As in the case of the insect mouth, the modifications of the rotifer mastax may be referred to more or less suppression of some parts and extension of others, and, whether Mr. Gosse's comparisons of the mouth organs of the two groups be completely accepted or not, very interesting and important lessons may be learnt by studying them together. Fig. 2, representing the mouth of *Notommata clavulata*, shows a considerable simplification of fig. 1, and fig. 3, *Furcularia marina*, a still more remarkable divergence

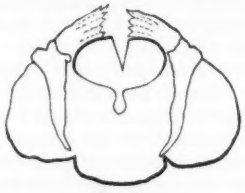

Fig. 2.

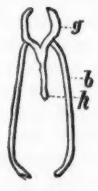

Fig. 3.

in the direction of simplicity. Those who wish to study the various forms in detail should consult Mr. Gosse's remarkable paper in the "Philosophical Transactions,"* illustrated by eighty-five drawings. Dr. Hudson is giving, and no doubt will continue to supply, sketches of the mouth organs of the various British species as his work progresses. This monogram would be improved by giving a little more information in the letterpress, and supplementing the uselessly large figures with more anatomical detail. A drawing 6 inches long, showing no more than would be displayed perfectly in one of 2 inches, is a mistake. It is

* February and March 1855.

also injudicious not to indicate the amount of magnification in each case.

Amongst the rotifers with comparatively simple mouth-organs those belonging to the *Asplanchna*, or bowelless species, are of great interest, as their perfect transparency makes it easy to work with both high and low powers. The biting machine of *Asplanchna* is like a pair of young deer's antlers, with sharp projections. It is a nipper, not a grinder, and often lets swarms of live objects through without noticeably injuring them. The voracity of the creatures is amazing, and the present writer supplied some curious illustrations of this in the "Intellectual Observer" (vol. v. p. 182). In the stomach of one *Asplanchna* were seven small rotifers, the jaws of an eighth, one arcella, a quantity of imperfect crystals, perhaps uric, together with a mass of matter sufficiently digested to conceal its origin. The stomach of these creatures is very elastic, and is not inconvenienced by large hard objects that force it quite out of shape. When it is tired of them they are pitched out by the way they came in, together with other indigestible débris.

An exceedingly voracious animal, which bolts its food at a rapid rate, evidently throws hard work upon its stomach. If we have to stew a mass of matter quickly into a soft pulp, we stir it well about in hot water. The *Asplanchna* is not provided with a spoon for this purpose, but its stomach is lined with active cilia, and they force currents of the digestive fluid in all directions amongst the objects to be acted upon. The direction of these currents fluctuates as the resistance gives way, and the sight is a fine one with powers of from 500 to 1,000 diameters. Fig. 4 is from a sketch made by Mrs. Slack under the

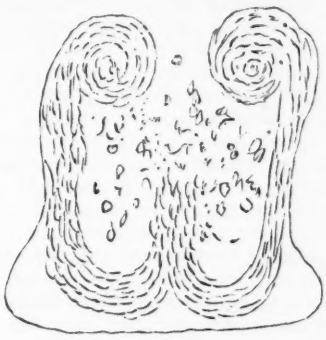

FIG. 4.

latter magnification. It would be an interesting task to examine a variety of rotifers and see in what cases stomach currents were employed as important aids to digestion.

The aspect of the mastax of many rotifers as seen in one position when the creatures are alive is apt to mislead the observer in imagining a form they do not possess. The organ should be viewed in all directions, both while it is in the animal and after the whole of the soft parts have been removed by solution of caustic potash. Mr. Gosse frequently found it necessary to cause the apparatus to turn over, which can be done by using the screw of a compressorium and making wavelets in a water-drop holding the object.

With every wish to recognise and welcome "The Rotifera," and to give due credit to Dr. Hudson, we cannot help wishing Mr. Gosse had been able to take a larger share in the new work, which would then have been free from the blemishes pointed out. The third part, lately out, describes and figures many of the most interesting genera, including *Asplanchna*. The three parts are intended for one volume, but we imagine most purchasers will consider it too thin and bind all together when complete.

THE NATURALIST'S LABORATORY.

CONTRIBUTION I.

DURING the past few years the rapid progress of natural history, which has marked our era as pre-eminently the scientific age, may be claimed with justice to have resulted chiefly through the importance attached to practical laboratory work. All our most eminent teachers are agreed that a sound scientific training must be a permanent educative process; that a true knowledge of the forms and functions of living things, as well as of inert matter, can no longer be regarded as attainable through pure speculation, or anything which savours of things metaphysical, as it was in mediæval times, but must be sought for by each worker through diligent observation and experiment. A sound preliminary training, adapted to lead the student to future original research, is thus reduced to one of actual practice. His first step must necessarily be one of verification; he should not take for granted that what previous workers have stated is absolutely true, but endeavour to ascertain by experiment the actual worth of their records; for, in the majority of instances, personal errors play an important part, so that when researches are published it would be of great value to future investigators if the authors would always note the precise plans followed in attaining results from which they deduce their conclusions. To a neglect of this duty may be traced much of the aimless disputes which characterise the terminations of many so-called learned societies' proceedings; whereas, its observance would afford a ready means to other workers for the correction of individual errors and the advancement of truth. Such a plan, if universally followed, would also enrich the laboratory immeasurably, for every original paper would contain notes of some instrument, some receipt, or some novel method of value to be added to its stores.

The naturalist's laboratory of to-day is very prone to degenerate into a kind of lumber-room, because of the want of definite information in a compact form, to meet the requirements of the present day. The principal aim of the series of contributions of which this is the first, is to supply a systematic compilation of notes for the guidance of both private and public students, to enable them to derive the benefit of all the most valuable results of former workers, both ancient and modern, to the utmost, and thus to facilitate research.

Until recently the term naturalist was applied more exclusively to certain lovers of the beauties of nature, who prided themselves upon studying the general habits of plants and animals, making collections of their dead remains, and naming them after separate fanciful codes. The naturalist's laboratory of the time of White of Selborne, or even of the late Sir William Jardine, wore more the aspect of a kind of old curiosity shop than of a scientific worker's *sanctum*; where birds' skins, dried plants, cured insects, shells of molluscs, and fossils were carefully stowed away in drawers redolent with camphorated essences, &c. The mania for merely collecting and arranging was not then confined, as it is now, to what are aptly called "scientific amateurs," but was followed more or less by all the leading men of the day, from Linnæus downwards. It has at length been fortunately developed in the right direction, and public depositories in the form of museums of science and art have been widely instituted. Here the storage of birds' skins and dried plants assumes its normal place; they are of specific value to the general taxonomist, and, when carefully prepared, are second only to elaborate and accurate works of pictorial art.

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The prevailing idea amongst the older biologists of the present age seems to have been that a collection of birds' skins, cured, stuffed out with cotton-wool, and laid ensheathed in wrappers like mummies, fulfilled all the requirements of the scientific taxonomist; they were, in the true sense of the term, taxidermists, and nothing more. Gradually the term taxidermy was applied, not so much to the classification of skins as to the art of curing and mounting them, and the taxidermist degenerated into the pet preserver of poodles, parrots, and canaries. This, however, exercised a beneficial influence upon the art of skin-preserving, and in most of our museums we find examples of stuffing of rare excellence. The life-like attitudes of animals first initiated by Waterton, who is supposed to have latterly carried out a craze for blowing his skins out with air, was quickly followed by others who made a business of it. The highest development of the art which it has been our good fortune to witness has without doubt been only recently achieved by Saville, many of whose *chef-d'œuvres* are now in the possession of a Mr. Chase in Birmingham. To describe any of his works will be to give an outline of the most successful results of this kind that have hitherto been achieved. One case, which may be taken as an example, consists of a group of graceful water wagtails in their natural habitat; the postures of the birds are life-like, each one having been carefully studied from nature through the untiring energy of the artist: every feather, ruffled or smooth, is naturally set; the imitation glass eyes, the very eyelids, beak, feet, and nails, are all covered with some material which imparts to them a freshness of form and colour which can scarcely be distinguished from the living tissues even upon close inspection; the general surroundings, moreover, are all modelled after nature; every stone, every blade of grass in the case has its prototype in the fields. When brought to this state of perfection, the preservation of skins is at once raised to the rank of a fine art, and ought to be valued accordingly; but to the searcher after the truths of nature it must be regarded as an item of minor worth.

Dried skins, dried plants, the shells of molluscs, and preserved insects, are, in the present state of our knowledge of animated beings, useful merely for the purposes of provisional, specific, and varietal classification, for absolute knowledge concerning the genesis and relations of the many forms of life can only be gained through exhaustive experiments in the domain of anatomy and physiology, both mega- and microscopical. When the skins &c., however, are employed by artists to depict phases in the life-habits of the organisms, their value to the naturalist becomes greatly enhanced, and it will therefore form part of our future duty to record a series of notes upon taxidermy as it is now practised.

Fossil remains afford a more extensive field for inquiry than the mere dried integuments of living things, for here nature very often operates as a dissector, and reveals structures by means of which many problems of great importance are capable of being solved. Fossilisation is now understood to take place under only peculiar circumstances; the soft-bodied creatures which inhabit the waters of the globe are but seldom preserved, since, upon sinking to the bottom, their bodies rot away till no trace of their former existence remains; thus it is that very few anemones of this nature are preserved. But where the anemone develops a hard skeleton that remains preserved either in the form of a pseudomorph (where the original particles have been replaced by others of secondary derivation) or in its primæval condition, a fossil coral is the result. The shells of molluscs are perhaps best suited for preservation, and are situated, whilst living, in the most favourable conditions for becoming fossilised: they are thus found in abundance as fossils, and have been taken as the basis of classification of typical formations in the geological record. Terrestrial plants and animals, the latter especially, are fossilised only under accidental circumstances, their bodies, submerged in former lakes, decay away, to leave little beyond the internal framework or skeleton; and it is thus that nature acts as a dissector, for the specimen preserved in this way affords evidence of the true place in nature of many living forms whose relationship is thus undeniably proved by the petrified remains of their extinct missing link. The collection and preservation of fossils is hence well worthy of the attention of the naturalist, and we shall devote some space to the consideration of this subject in the sequel.

To pass back to living things, of greater importance than the collection and preservation of skins, &c., comes the study of bones, or osteology. It is the basis upon which the young anatomist should found his future work, for he can never understand anything of importance connected with his subject—the movements of the muscles, the disposition of the blood-vessels and nerves, &c.—without first grasping the significance of form and relations of bones. There can be no doubt that the best way to become familiar with the osteology of any animal is the practical one. By preparing and articulating the skeleton of any one subject, a more permanent knowledge of its bones will be derived than by any amount of study with a skeleton prepared by others. Practical osteology and articulation, followed after the directions which we shall give for cleansing and mounting certain typical examples, will, we trust, stimulate students to future accurate anatomical research.

Although it is not our intention to make this a dissector's guide to the anatomy of any group of animals or plants, special attention will be paid to the general methods of research, which are seldom, if ever, adverted to in the many current text-books of anatomy and physiology. This will enable our readers to follow the best plans, and to use the instruments best suited to their requirements. For instance, in working out the anatomy of the common earth worm, if the subject is not properly prepared beforehand, carefully fixed in the right position in a bed of material of the right consistency, and operated upon with scalpels and needles of particular designs, the utmost skill will not avail, and the work of the dissector become a painful labour instead of an interesting study. These remarks apply equally to other departments of practical anatomy where special instruments and processes have been invented from time to time to render the work of the investigator pleasant, simple, and successful. The preparation of anatomical specimens for museums will here be taken as the foundation whereon to build up this portion of our laboratory.

The preservation and preparation of living things, as well as of inorganic materials, presupposes that they have been captured or gathered in some way or other, and in many instances the naturalist is forced to cater for himself. Field work is, indeed, one of the most important of the student's duties, and although it cannot be regarded as any part of his occupations within the walls of his sanctum, all nature must be looked upon as his workshop, and in that sense the tools which he requires for dredging, pond-hunting, insect-capturing, stone-breaking, &c., will afford scope in the sequel for a series of discourses upon excursions.

Half a century has passed since the most important addition to the naturalist's laboratory was made in the form of the compound microscope. With its assistance an ever-increasing field for research has been opened; but the biologist and geologist are here both hampered with numerous difficulties, for, before the instrument can be worked to its full advantage, the majority of objects require to be specially treated so as to reveal their characteristics.

Our observations in this department will, however, be confined to the equipment of the work-room rather than to a detailed account of microscopic objects, which are discussed in another portion of this journal.

But to return to the laboratory *per se*; there can be no doubt that, although a special apartment wherein to conduct research is not absolutely necessary, yet, where such is available, it tends very largely to secure that comfort and convenience which lead to an inducement to labour. On this account the selected chamber should be so constructed and arranged as to embody all the necessary hygienic modern improvements, in addition to the special requirements of the student. It will not, therefore, be out of place if we devote our next contribution to a consideration of the salient features of a thoroughly well regulated naturalist's laboratory.

AMERICANISMS.

(Alphabetically arranged.)

By Richard A. Proctor.

[A good-natured critic, of the cheap (and "nasty") sort, kindly characterises these notes on American expressions as "cribbed from Bartlett." As I indicated at the outset my obligation to Mr. Bartlett, I do not consider that I need now say anything further on that point, except to note that I have found his book much less trustworthy than I hoped, and that therefore my obligation is much less than I had expected it to be when I frankly referred to it by anticipation. Yet a critic who has never seen Mr. Bartlett's "Dictionary of Americanisms" is, doubtless, quite honest, however ill-informed (and unmannerly), in describing me as "cribbing" from it.]

Different from or *to*. They assert in America that we in England say "different to," whereas over the water they more correctly say "different from"; in other words, they claim to set us right in regard to the use of the word "different." It is hardly necessary to say here—i.e. in addressing English readers—that with us "different to" is regarded as an offence against grammar quite as much as in America. I had repeatedly noticed "different to" in American writings, and supposed it was a fault of speaking which they shared with our ungrammatical classes, until one day I heard it said that the fault was peculiar to English writers. I suppose some Americans, acquainted with the proper way of using the word "different," that is, in company with "from," and reading English books with the idea of noticing characteristics of English writing, have paid more attention to the mistake of using "to" after "different" in English books than in reading American books. But I can assure them that in American works the mistake is quite as common as in English. In like manner, I have been assured in Scotland that in England we much more commonly say "he laid" for "he lay," or "it lays" for "it lies," than they do in Scotland; whereas, on the contrary, English readers when they come across the mistake in Scottish writings, suppose it to be a peculiarly Scottish mistake. Bad grammar is spoken wherever the English language is spoken.

Difficulted. For "perplexed." This is peculiar to the South, and some assert to Georgia. In Scotland, however, it was formerly used, and the verb *to difficult* appears in Jamieson's "Scottish Dictionary."

Diggings. This expression for "a place of working," and later for "a place of abode," had its origin first in Western America at the lead mines. A man's *diggings* were the place where he was digging for ore. The expression would hardly have originated except in a community where everyone was employed in the same way, or extended readily except in a nation where to work is considered the duty of every man, and idleness degrading.

Dime. A silver coin worth ten cents.

Dime Novels. Trashy novels, because the novels sold for a dime are usually trashy. Yet no English novel-writer can be sure that his works, especially his shorter stories, may not be sold for a dime in America, badly printed or even villanously illustrated.

Ding. Equivalent in the South for "darned." Short for

Dinged = "darned."

Dingee, Dinky. Same as our English "dingy."

Dip, Dipping. Some American ladies, especially in certain Southern States, take snuff in a particularly attractive manner. A little stick of pine, about three inches long, split like a brush at one end, is wetted and dipped into snuff. With the snuff thus taken up the teeth are rubbed, "sometimes by the hour together," Mr. Bartlett states. Others tie the snuff in a little bag and chew it. But the other way, called "dipping," is the more elegant. The lips assume a singularly lovely appearance after a few years' dipping.

Dipper. (1) A pan with a handle for dipping water. The seven leading stars in Ursa Major, which with us are the Plough and the Churl's Wain (or, by a curious corruption, Charles's Wain), are in America called "The Dipper." (2) One who takes snuff after the objectionable manner described under *Dip* and *Dipping*.

Dirt. In America the word "dirt" is used where we say "earth." Thus a road in America repaired with earth of any sort is said to be repaired with dirt. Bartlett says a turnpike road is a dirt road; but this is not a correct way of putting it. In Virginia, for instance, the turnpike roads are "metalled," and distinguished, as such, from unmetalled or dirt roads. Our children retain this older use of the word when they speak of an earth pie as a dirt pie.

> Sitting as good as goold in the gutter,
> A-makin' his little dirt pies.—Hood.

Disgruntled. Disappointed; disconcerted. The following extract from the "Springfield Republican" illustrates not only the use of this elegant word, but the bland and childlike ways of Young America:—"The Reverend Newman Hall, of London, tells how, when he was journeying to Chicago, an apple-pudding boy on the cars, without any preliminaries, took hold of and immediately examined his breast-pin. Nevertheless the reverend gentleman, quite *undisgruntled*, remarked, 'Was it not there to be seen? Was he not a man and a brother?'" The word may be met with in old English writings.

Disguised. Americans fondly imagine the expression "disguised in liquor" to be an Americanism. It is of course English slang, of great antiquity.

Disremember. Not to remember. Good old "bad English."

Distressed. Pronounced *distrést*. Wretched. "Poor *distrést* wretch," as we might say "*poor dévil*." Really, a nigger expression.

District schoolmaster. The master of a public (i.e. free) school in a district. The master of such a school seems to be mostly a poor distrést wretch, in the most emphatic sense of the words. Generally pronounced *deestrick*.

Dite. This word, the equivalent of our old English "doit," is an interesting New England survival. "Not a doit I," we find the Elizabethan saying; and now in New England, "I don't care a *dite*."

Divide. A watershed. I have never heard this expression used out of America, and only in Western America.

Divort. Bartlett finds this word distinct from *divide* in implying elevation as the cause of the division of waters.

Dixie. The name of a very kindly slave-owner on Manhattan Island, whose slaves, increasing faster than the land, had to emigrate. After his death his virtues as a master assumed a semi-mythological aspect, and Dixie's Land became an equivalent for a sort of nigger paradise.

Dodger. Hardbaked cake or biscuit. Thomson says this word is a corruption of *Deadgarred*, thoroughly done. Let us hope so.

Do don't. Nigger English for *don't*—showing the taste of lower races for reduplication.

Dod rot it. Americans claim this as a pleasing relief-expression. But it is tolerably good old English mock profanity, like "'Od rot it" (or "him" or "them" as the case may be).

> What are they fear'd on, fools, *'od rot em?*
> Were the last words of Higginbottom.

And Higginbottom was not a Yankee.

Dog-goned. This, however, may be American. In the "Farm Ballads"—

> But when that choir got up to sing,
> I couldn't catch a word;
> They sang the most *dog-gondest* thing
> A body ever heard.

Dogged. For con"demned" theologically. I'll be dogged if I do.

Doings (pronounced *doins*). Food provided for a guest or company. See *Chicken-fixings.*

Do, used instead of "do for," seems peculiarly American. "That will do me," *i.e.* suit me.

Donate. Americans try to persuade us that the word "donation" is American. But of course donation for a gift of considerable value is found in English writings of a time long preceding the Day of Independence. "Donate," however, as a verb formed from "donation," as "collide" from "collision," is unquestionably an American word, and a very unpleasing word it is.

Donation Party. A party collected to make presents to a clergyman, where the parishioners are not generous enough to give him a suitable salary.

Done, used instead of *did.* Bartlett makes the odd remark that this vulgarism is common in the State of New York, and also heard in the province of Leinster, Ireland. (This reminds one of the example in the "Art of Sinking," which tells us how a person whose name I "disremember" was not only

> The great god of war,

but also, and moreover, was

> Lieutenant-Colonel to the Earl of Mar.)

Done for *did* is a common vulgarism wherever the English language is spoken. It is only an Americanism in being heard oftener in America than in the old country, and especially in being heard among classes who might be expected to know better.

Done used in an adverbial way is a negro vulgarism. "*Done* gone" means "gone quite away," as Mrs. Nickleby's admirer put it. "He's done gone and done it" is a singularly emphatic bit of nigger phraseology. "*Done* dead" means rather more dead than mere death unqualified would imply: the expression is known to be of negro origin, or one might attribute it to "Leinster, Ireland," and also to Ulster, Munster, and Connaught, where one may not unfrequently hear the expression "murdhered inthoirely."

Don't amount to much. Mr. Bartlett is kind enough to explain that this corresponds with what we mean in England when we speak of any one as "no great shakes." But "don't amount to much" has been used in England a good deal longer than Mr. Bartlett imagines, and "no great shakes" is sheer slang—in England (and in America too, where this expression, probably derived from apple-growing regions, is often heard).

Doted. Changed, or half-rotten. Probably equivalent to our old English *doited.*

(*To be continued.*)

AMATEUR PHOTOGRAPHY.

By T. C. Hepworth.

THERE was recently shown in one of the Bond Street galleries a collection of more than two thousand photographs, the whole of which were the work of amateurs. The idea of holding such an exhibition originated with the London Stereoscopic Company, by whom valuable prizes were offered to competitors in several different classes of subjects. Thus one class was reserved for marine subjects, another for landscapes, another for the work of beginners, and so on. Without entering into any detailed examination of the various pictures exhibited, we may usefully call attention to several points in connection with them which seem to us worthy of remark.

Not alone did this exhibition show an advance in general acquaintance with photographic manipulations on the part of amateurs, but it illustrated in a remarkable manner several important steps in the recent history of photography itself. In the first place, every picture here without exception owed its creation to that system of dry-plate photography which came upon us like a revelation only six short years ago, a system which has rendered possible the "delineation" of so-called instantaneous effects. Nor was this collection of pictures devoid of several excellent examples of this most startling application of the camera. Here, for example, was a marvellous rendering of a flash of lightning which at once called to mind the branched, crackling discharge from a large induction coil. How different this from the stereotyped zigzag line which artists for centuries have been content to accept as a typical representation of the thunderbolts of heaven! Passing from things sublime to those of a very mundane character we saw in Dr. Alabone's instantaneous studies a boy playing leapfrog, and actually for the moment poised with his finger-tips on the bowed back of his companion in sport. In the same frame were a couple of swimmers in the act of entering the water from the top of that unpicturesque object, a bathing-machine. Both were in mid air, one taking a fair "header," and the other turning a summersault.

Another recent advance in photography was illustrated by the large number of pictures which were printed by the platinotype process, and which, apart from their engraving-like, artistic appearance, have the merit of undoubted permanence. The discoverer of this process is able to boast that no chemical agent short of warm *aqua regia* can destroy the platinum image. In other words, the picture is far less destructible than the paper which supports it. Then, again, in the many representations of mountain scenery we had an exemplification of the very latest advance in photographic art, whereby the tourist is relieved of the weight of glass, and can take his pictures, panorama fashion, on a roll of prepared paper, otherwise known as the "Eastman film." By this new system the weight of apparatus is reduced to such an extent that an Alpine climber is able to carry his camera to altitudes

which, under the old condition of things, would remain inaccessible to the photographer unless he were accompanied by a retinue of porters.

It is evident that the time has gone by when critics could turn from the work of amateur photographers with a sneering word, and we may feel sure that John Leech's inimitable satires in this direction would, if published now, entirely lose their point. With opportunities of "taking" all kinds of different subjects, with means and leisure to search the world over for unfamiliar scenes and curious character-studies, the amateur worker has many advantages over his professional brother, who is bound to consider the bread and butter side of the art before everything else. If there be any who hold that this fashionable hobby of photography is a disadvantage to those who are professional workers, let them remember for a moment that it is those very amateurs whom they blame to whom the credit is due of bringing the art to its present perfection. Ten or twelve years ago, while the professionals were busy making their living, and in numerous cases a very good living, too, by taking portraits by the old collodion process, there was a handful of amateur workers who were spending their time and money in experimenting. They were anxious to simplify photographic manipulations by preparing the chemical film as a dry surface, so that wet plates, collodion, and all their attendant messes might be superseded. Gradually it leaked out that these workers were elaborating new methods of procedure. At first they might be counted on the fingers; then they increased by tens and twenties. In the meantime the professionals laughed at these efforts, and said that the new methods were toys—all very well for amateurs, but which could never oust the old well-tried wet-plate process. Suddenly working details of gelatine plate-making were published, and pictures were produced which showed their marvellous capabilities. The professionals at last woke up from their sleep of fancied security, and now every worker in the kingdom puts his trust in the once despised gelatine plates, which owe their origin to the equally despised amateurs.

To return to the Bond Street Exhibition, we note that the majority of the pictures shown naturally consisted of landscape studies, for such subjects abound on every hand. Next, there were bright little peeps into that happy home-life which is no less characteristic of old England than are its shady lanes, its breezy downs, and its chalky cliffs. But beyond these there were pictures which were of peculiar interest as being valuable from a scientific point of view. We have already noticed the truthful representation of a lightning flash. Many other natural phenomena can be far more readily pictured by King Sol, as was proved by many of the subjects in this collection. A geologist could trace out in more than one of them the old, old story told by the rocks. Here a beautiful example of stratification; there a mass of basalt, crystallised ages ago, from a heaving molten mass into beautiful hexagonal pillars; here, again, some isolated rock masses which, in a far-off period, have been pushed from their bed by the action of ice. But here, too, are glaciers in actual operation. In some most perfect photographs by Mr. Muller (scenes in the Engadine) we can trace the very life history of a glacier, from its first advent as fleecy snow, then its gradual descent—a sea of ice—down a winding valley; and lastly, we can discern in its melting foot the source of some mighty river. In another picture is seen the gradual advance of a storm cloud over a mountain top, which presently will expend its fury upon everything around, including the luckless photographer who dared its wrath. Close by, as a contrast, is a scene full of sunlit tranquillity—an orange-grove in Florida, with the luscious fruit as thick upon the trees as apples in an English orchard. Here, too, is a collection of flints from Kent's cavern (Torquay) which would delight the heart of Mr. Pengelley. Lastly, let us notice some exquisite examples of photo-micrography, an application of the art which has recently been much developed, and which threatens to supersede altogether the tedious, elaborate, but less accurate work hitherto done by the camera lucida.

We have said enough to indicate that amateur photography is no passing fashion which will presently, like a new bonnet, give place to some fresh caprice. It is an occupation which many take up with far more serious meaning than they would a mere pastime. In good hands it represents a valuable educational aid, from the necessary elementary knowledge of chemistry which it forces so pleasantly upon the attention of its votaries, to the study of Nature in her varied aspects, a study which, to those who strive to learn, is one of the highest privileges which this beautiful world confers upon mankind.

It would not be fair to close our remarks without acknowledging the generosity of the London Stereoscopic and Photographic Company in inaugurating this their second exhibition of the works of amateurs. We have all the more pleasure in doing so because the profits of the undertaking are devoted to a most deserving charity.

SOMETHING ABOUT THE ELEPHANT.

A CERTAIN dear old book says about the lordship of man over creation, "And the fear of you and the dread of you shall be upon every beast of the earth" . . . "and a little child shall lead them."

Nowhere is the truth of these sentences more distinctly seen than in the contact of man with the elephant, nor more marvellously than in the tacit subjection of its enormous mass and power to the tap of a child. Many a time have I seen, and with amazement, the huge animal following the lead of a mere mite whose only guiding was pressure with its palm on the great swaying trunk, the faintest hostile move of which would have yielded momentum sufficient to have destroyed the child.

Mark this mahout mounting his elephant by its trunk; seizing the tips of its ears, he places his feet on the trunk, and the dear animal at once lifts it and him upwards, and thus the mahout gains his seat upon its neck. It is remarkable to see this, inasmuch as the life of the driver is wholly at the mercy of the elephant, who can easily with the faintest move of his trunk pay off any old grudge against him.

It is remarkable to see this great animal in motion. As with the whale, so with the elephant—bulk does not add clumsiness to movement, but the reverse; you will see the elephant progressing silently, and apparently picking his steps, for each great foot is put down leisurely, not at haphazard. Unlike other animals, he can never get out of a walk, but he can walk very fast when excited, perhaps six miles an hour.

Some years ago an enraged elephant was able to overtake and kill his grasscutter, and this on a fair and open plain where speed was in favour of the man, but of course he had not the endurance of the elephant.

Apropos of the silent progress of the elephant, it is marvellous how he can, in his wild state, move through his native forest without being heard; nay, you may actually be beside him, yet be not aware of his presence.

The elephant seems a link with a lost fauna, for all round

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he stands alone; the only approach to his trunk being that of the tapir. His drinking is unique; all animals drink by so-called suction, but he drinks by suction and pour—that is, he fills his trunk by suction, and then pours it into his water-stomach, where it is either assimilated or utilised again by the trunk and blown in grateful spray all over the heated body. The action of drinking is highly characteristic; of course in his native haunts he drinks from a river, or water-course, or tank, and wallows in either at pleasure. In captivity he rarely has this pleasure, but is watered from a bucket, leathern or wooden, and then he is quite satisfied as long as the tip of his trunk is fairly immersed.

I am not certain whether the elephant drinks by suction or vacuum (of course the former implies the latter, but it will be seen that there is a difference), and I have never seen the question discussed in the books. The following is the process: Water presented to him he at once blows down the trunk and then instantly immerses it; after a while he curls up the tip, and lifting the trunk and prolonging the curl he brings the tip into his mouth, throws back his head, and blows out the water, which you distinctly hear splashing in a cavity.

This process (and it is a slow one) goes on until he is satisfied, and then he clears out his trunk with a blast; as he breathes through his trunk, it is only in these intervals that he can inspire. If he drinks by vacuum, the following is the process, presumed at least: Simultaneous with the blast the posterior nares are closed, and the trunk is in vacuo; water rushes in by atmospheric pressure, and the trunk is filled and empted as above. This trunk is a wonderful organ, and the only instrument of prehension possessed by the animal, and it will as deftly pick up a needle with its finger as a bundle of sugar-cane with the whole organ. It is also, though very rarely, his weapon of offence, and a very formidable one, and yet a mosquito will keep it in check; and it is through his trunk that you win the animal's affection. Go up boldly, and in front, to a strange elephant and fondle his trunk, and you are safe; approach him from behind, and he will edge away from you suspiciously sideways, perhaps with trumpeting.

Like the whale, the range of an elephant's vision is very limited, and he has to move the whole body to take certain observations; therefore he is virtually purblind, and this makes him suspicious. He can't see anything on the ground below him, and his finger here takes the place of a third eye. It is great fun to approach him with a stick of sugar-cane behind you; its fragrance soon reaches his sensitive nostrils, and you will find the dear creature exploring your rear with his trunk-finger, grasping the cane gently, and removing it to his mouth.

From earliest antiquity the elephant has been utilised by man; we read of his achievements in war, when he used to carry a turret on his back charged with from six to eight warriors; now his maximum load consists of the howdah, with perhaps two sportsmen in front, and an attendant behind; this is for sporting purposes.

His main use now is to swell the effect of state pageants, and it is certainly a grand sight to see a long array of these noble animals, in all the bravery of their gold and silver howdahs, bells, and embroidered trappings. Many of these animals are of great age, and have historic associations connected with them; thus, it was only in 1873 that Warren Hastings' state elephant died on its way from Agra to Lucknow, on the occasion of Lord Northbrook's great Durbar. What an autobiography that animal might have written.

I do not know which is the most impressive sight—to see the wild elephant crashing through the forest, frightened out of its wits by the discharge of your piece, and trumpeting wildly in fear, or to see it in the majesty of intelligent subjugation, moving grandly in its place in the 40-pounder battery, and utterly regardless of the roar of the great guns.

And this reminds me that in her 40-pounder elephant batteries India possesses weapons of offence unapproachable by any other nation. One of these went into the Khyber Pass in the last Afghan war, and opened fire upon Ali Musjid at 3,500 yards; only the crest of the fort was visible above the plateau, yet it was reduced to ruins (though answering gun for gun), or, as the telegram stated, "Ali Musjid in rags."

Let us watch one of the majestic batteries on a field day—here they come, four 40-pounders and two great howitzers, each harnessed to two elephants, one in shafts and the other in front, with chain traces attached to the ends of the shafts. The mahout (driver) sits on the neck of each; note the docile animals as they grandly march up in two lines of six each, as they pass the flag they elevate their trunks S-like in salaam, and move on with stately tread. After the march past, and for manœuvring, twenty great white bullocks in war, and sixteen in time of peace, relieve the elephants, which cannot get out of the walk, and trot the guns all over the field.

The food of each of the elephants consists of, daily, 15lb of flour made up into nine cakes, or chăpátís, and 6 maunds of kerbi (Sorghum) for each large, and 4 maunds for each small elephant (1 maund=40 seers=80lbs. av.). To wash down all this, each elephant drinks, four times daily, according to size, two or three skins of water (măshăk), each skin holding one and a half maunds of water, and he has two baths daily in the hot weather, and these he enjoys thoroughly.

When all is quiet, about 10 P.M., elephants retire to rest, throwing themselves down on their right sides, and sprawling comfortably; for some time you will see their left ears flapping nervously, and the old trunk twitching, and then all is at rest—

> And these here mighty Pachydarms,
> Are fast asleep in Murphy's arms.

Though their skins are immensely thick, they are wonderfully sensitive, even to mosquito bites; I have seen an elephant feeding off bibal branches (*Ficus religiosus*), suddenly stop, take a branch in his trunk, scratch his back therewith, and then throw it away. Another, troubled with a loose tooth, was seen by a commissariat officer to insert his trunk into his mouth, and pull it out forthwith.

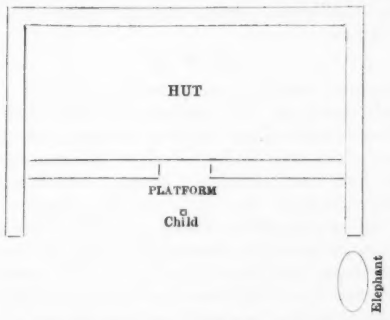
As I have already hinted, elephants are gentle, docile animals, and the exception denotes an exceptional mahout: he wields a formidable weapon, a relic of ancient barbarity, called the ănkoos, which I here represent, and according to his use thereof so is the temperament (misáj) of his animal; the inner edge of the hook is sharp, and is used with fearful cruelty on the lobe of the ear, while its sharp point is driven ferociously into the tissues of the vertex, exposing the yellow fat beneath the skin. The poor animal shrieks under the agony of these cruel prods, and I will presently show how he righteously treasures up wrath against his cruel mahout.

Not only is the elephant used in war (including transport) and state ceremonies, but he is also largely used in sport, especially tiger shooting, and here his strength, intelligence, and endurance are invaluable; he is also invaluable for draught, and in this respect I do not hesitate to affirm that the Burmah teak trade would collapse without his marvellous strength, intelligence and docility.

Once I had an elephant as my patient, and a touching case it was; the poor brute had a huge ulcer beneath its left elbow, as big as a slopbowl, and this the mahout used to fill up every day with pounded leaves of the *Croton tiglium*, and it was piteous to behold the agony of the animal during the application of this irritant. I consented to take the poor creature in hand, provided it was sent over to my house; this was done, and the relief of cotton wool soaked in weak carbolic was very striking. The next thing I heard was that the mahout had removed the elephant, because he could not be bothered to walk to and fro a mile for his own dinner, and the next, that the poor brute had dropped dead suddenly, after its walk back. A post-mortem, carried out with saws, axes, and hatchets, revealed an enormous fibrine clot in the left heart as the cause of death. I was also able to certify myself that in the elephant the testes were in the abdominal cavity.

Like other animals, elephants are apt to become insane, and then they either become maudlin or dangerous; a *mad* must not be confounded with a *must* elephant, an animal whose sexual στοργή has, ignorantly, not been satiated; but on the contrary, his fury has been excited by cruel treatment and the internal exhibition of highly poisonous and irritant drugs. A must elephant at large is a highly dangerous animal, and frequently death and destruction are in its track.

And now I will wind up these notes with an account of how an elephant paid off his mahout at Allahabad during the mutiny. The man was a merciless brute, and the animal long stood his cruelty, though, times without number, he had had the mahout in his power; the final retribution will be understood by this sketch. The day's



work over, the mahout dismounted at the platform of his hut, on which his child was awaiting him, went in, brought out a broom to sweep all around, leaving the elephant standing at one wall; several times he passed unhurt, until the elephant seemed to awake to the opportunities it had lost, and the next time the mahout passed between him and the wall, it moved forward a few inches, and five minutes after, when I saw the dead mahout, his face was at the back of his head. The dead man's child of four (he had no wife) led the elephant to its tree by the trunk which had slain her father. And thereafter the executioner would have no other guide.

R. F. HUTCHINSON.

Theologians of a certain class explain the discrepancies between ancient ideas about scientific matters and the actual facts in so many different ways that they ought to cease from accusing Science of contradicting the Bible until they have ceased to contradict each other. When they all agree in telling Science just what it is she contradicts, it will be time enough for Science to look into the matter a little.

Gossip.

BY RICHARD A. PROCTOR.

MUNICH has been so often and so fully described that I do not find much to say about my visit there. Some features of the place seem worth noticing, however, even though I may be going over much-trodden ground.

* * *

I WONDER whether a theatre could by any possibility be managed as successfully in London as all the theatres are managed here. To take the opera, which seems most completely to foil the efforts of managers in England, America, nay, in most parts of Europe and even of Germany. For the best seats in London the foolish public consent to pay a guinea, in order that singers like Patti, Nilsson, and Albani may be paid two hundred pounds a night and make a fortune for early squandering, after the manner of great *artistes*. In Munich the best seats at the Hof Theatre cost five shillings, though the singers are excellent—truer, as artists, than many of the stars so admired for mere roulading and high-note striking. But this is not all. In the chief opera-houses in London you can never expect to be free from the annoyance of some loud-speaking, unmusical neighbours, who mar the sweetest passages with their idle chatter. Once, perhaps, in ten visits you escape this annoyance, but the chances are much against this. In Munich no one wants to talk, they all come to listen and enjoy and let their neighbours enjoy. If any one should talk, his neighbours quickly assert their rights.

* * *

IN England you never escape the annoyance caused by those restless folk who *must* get out between every act, trampling over ladies' dresses, upsetting opera-glasses, gloves, programmes, &c., on their way. The number of persons unable apparently, through some congenital brain weakness, to sit quietly for two or three hours, is so great that not once in a thousand visits to opera or theatre are their idiotic movements escaped. In Munich such movements are the exception, not the rule.

* * *

THEN, again, those foolish folk who come late are allowed in England and America to spoil the pleasure of the more sensible. In Munich and elsewhere on the Continent the doors are closed at the beginning of each part of a performance, and those who arrive late have to wait until the part in progress when they arrive is completed. This is an admirable arrangement, and falls as a just punishment on the foolish and selfish. Yet another advantage is found in the sensible hours at which the theatres open. Of course the fashionable world in London and New York must dine late, and if they go to the theatre at all (which they might as well omit) the theatres must open later, so that the persons who form the bulk of the audiences must either lose part of the performance, or be content to get home after midnight. But I fancy the theatres would not have smaller audiences, and they would certainly have better ones, if they adopted the Munich plan of beginning at seven (or even half-past six for long operas) and seldom remaining open after ten.

* * *

APPARENTLY the absence of an orchestra when plays are acted enables the managers to secure good all-round companies, and also prevents those long "waits" which discredit so many of our performances in England. I scarcely know which of the three advantages to consider most important; but perhaps most of us will agree that the avoidance of the atrocious music which in nine cases out of ten fills up the intervals in our theatres is even a greater gain than either

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of the other two, great as they doubtless are. Think, however, of the satisfaction of first escaping the wearisome monotony of hearing badly-played dance music; secondly, having two or three hours wholly occupied by acting thoroughly good throughout—no weaklings marring the efforts of the better players, and lastly, not having to wait more than a few seconds between each act. Thus, to take yesterday evening (I write on May 6), we had "Der Geizige" (Molière's "L'Avare") and "Der eingebildete Kranke" (Molière's "Le Malade imaginaire"), admirably rendered, and followed by an interesting scene in which all the actors, in plain evening dress, joined in presenting a tribute of esteem to Herz on his completing the fiftieth year of his stage life, all being concluded before ten—three hours of perfect enjoyment from beginning to end. Naturally the Munich theatres are always full, except when, Patti or Nilsson coming here, the price is raised from five to twenty marks for opera or concert, and no tickets being taken except by a few Americans, those admirable singers decline to fulfil their engagements.

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I RECEIVE a great number of letters still in regard to the doubtful (in reality not at all doubtful) passages in Josephus. I fear that argument and evidence are quite idle in such a matter. For those who, either through self-interest or dulness of apprehension, can maintain a position utterly unreasonable, cannot well be convinced by reasoning. Their stronghold, the *Credo quia incredibile* of St. Augustine, is quite impregnable. Were it otherwise, however, it would be very little worth attacking.

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A CENTURY ago Voltaire wrote on this point, "All men of true learning are now agreed that the short passage relative to Christ in the history by Flavius Josephus has been interpolated." "The Christians," he proceeds in a note, "by one of those frauds called pious, grossly falsified a passage in Josephus. They invented for this Jew, so extremely zealous for his own religion, four awkwardly interpolated lines, and at the end of the passage they add, 'And he was the Christ.' What! Josephus had heard of so many events out of the course of nature, yet in the history of his country gives us but four lines about them! What! this obstinate Jew said that Jesus was the Christ! Then, if he believed him to have been Christ, he must have been a Christian. What an absurdity, to make Josephus talk like a Christian!" And then he calls to mind the much grosser impostures which, in the age of pious forgery, were piously invented to delude for their good the heathen who might otherwise have gone fatally astray.

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As to the passage about John the Baptist, theologians having not quite such overwhelming evidence (or evidence quite so obviously overwhelming) against this passage, accept it as a valuable confirmation of their views. (Their evidence is in any case only *ex parte*, and of very little weight except when they honestly admit, like Warburton, Butler, Stanley, and others, the weakness of much which the dishonest still continue to put forward as valid.)

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IT may be added to the objections cited (as a correspondent to whom I am already largely indebted points out) that: First, if Josephus had known about John what he is made to assert in this passage, he could not have omitted him in describing professedly *all* the sects and Jewish leaders. (But it was probably impossible to piously interpolate the necessary forgeries to obviate this objection.) Secondly, Justin Martyr, Tertullian, and Chrysostom could not but have seized on a passage so important; but alas! the pious interpolater came too late, and their eyes never rested on it. Thirdly, it praises John, though Josephus was a Pharisee, and John denounced the Pharisees. Fourthly, the interpolater being more pious than learned, so puts the story as to leave John's head to be brought a distance of a hundred miles from the citadel of Macherus to Herod; even on the most fiery "charger" this could hardly have been managed with the celerity indicated in Mark's narrative. Moreover, the charger on which the head was brought was of another kind. Fifthly—a mere trifle—the citadel of Macherus was at that time in the possession of Herod's bitter enemy Aretas.

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WITH regard to Zechariah the son of Barachiah, it is perfectly obvious to any one not theologically inclined, that whoever wrote the gospel of Matthew means to indicate the entire range of the innocent who had been slaughtered, from the time of Abel down to the time of the speaker who said that all such innocent blood should be on the heads of the Scribes and Pharisees. It is simply absurd to imagine that that writer imagined the slaughter of the innocent had ceased with the death of Zechariah the prophet, who probably died comfortably in bed in the time of Darius, ages before his time. Unfortunately, not being strong as a chronologist, the writer put into the mouth of a contemporary of Pontius Pilate a remark relating to an event which occurred after Jerusalem was taken by Titus, some forty years after Pontius Pilate, according to the same account (and also according to Josephus), had put his contemporary to death. It may be more respectable—more religious even—to quibble over this matter than to say that the writer of the narrative had made a mistake, but it does not seem so to me. Different persons see the same thing in such different lights.

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IT occurs to me as a noteworthy proof, for those who want such proofs, of the advanced scientific knowledge of the ancient Babylonians (or whomsoever they may have been from whom the old Jews derived their earliest records) that Abraham was promised a progeny equal in number to the stars in the sky. For it would have been a very poor outlook for the progenitor of a future nation (one progenitor—*plus* one *progenitrix*—was always held sufficient for a nation in those days) that his descendants should number a few thousands. But the actual number of stars in the galaxy would suffice for a quite respectable nation. In fact the trouble rather is, on this view, that the number of stars is too great for the prophecy, unless the Jews are hereafter to number some thousands of millions. Possibly we may reconcile matters (the difficulty has occurred to me only since I began this paragraph) by assuming inspiration equivalent in space-penetrating power to a telescope $10\frac{1}{2}$ inches in diameter.

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A CORRESPONDENT puts this question:—"Is it correct to say that, supposing a man to be able to reach, in one second, the remotest star visible, and were to continue on to all eternity, doubling his speed every second, that he would never get to the end of worlds, but would always have as many in front of him as he had behind him? It seems absurd, yet appears to be a necessary consequence of the theory that 'end there is none—lo—nor is there yet beginning.' If, on the other hand, the last star could be reached in every direction, then the universe not only has bounds, but is as a mere grain of sand in the desert of space. This seems as absurd as the other. Of course I here use the word 'universe' in its largest sense."

I FEAR that to this question there is but one answer, "We don't know." The infinite, which necessarily is, is necessarily incomprehensible.

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AMONG the signs of waning wit, in these hard days, must be recognised the increased favour in which mere word-playing is held. The comic papers, or those which now-a-days do duty for such, seem to rely more and more on this most insipid form of fun. Some, indeed, have been started with no other apparent object but to show what absurdities can be reached in that direction. But then *such* papers are only vulgar because written for a vulgar-minded class. It should be otherwise with papers like *Punch*, originally started, and long maintained, as exponents of genuine wit and humour. True, among the first writers for *Punch* must be counted some who were much too fond of that agreeable servant but most hateful master, the pun. But such a writer as Thomas Hood punned merely in the excess and exuberance of his fun; he had true humour and true pathos at his command. (It should never be forgotten that his "Song of a Shirt" came out in *Punch*.)

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WHY should an innocent public be disgusted by those atrocious illustrated puns which have so long appeared weekly in *Punch*? The pun is good fun enough when it comes in casually in conversation, though even there it wearies if the casualties are too frequent; and when suspicion arises that any one is really lying in wait for opportunities to pun, the whole thing becomes a nuisance, and conversation a weariness of the flesh. Even this, however, terrible as it is, seems nothing compared with the iniquity of a man who deliberately sits down, with a dictionary, to invent infamously bad puns, and then gets a fellow-conspirator to draw (or himself draws) a bad picture to correspond.

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ONE does not like to seem severe, especially on those who try to cater for our amusement; but really the editor and proprietor of a paper in which such cruel fun as this is allowed to appear should be subjected, for each offence (after the iniquity of their course has been shown them), to some really painful punishment—the perusal, for example, of a whole page of the *Topical Times* or the *Sporting Times*, or any of the organs specially intended for the vulgar. Obstinate persistence in wrong-doing might be properly punished by the infliction of a whole number, and, if the offender survived, by the order to commit to memory, and repeat daily, a dozen of the worst jokes (if any one could select them), or to analyse them, and inquire how they were probably invented.

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IMAGINE, for example, the state of a man's mind, outside Bedlam originally, who had had to analyse many such jokes as this from the *Topical Times*: "'Have you ever seen a hen stealing?' says the wife. 'No, but I've seen a cock robbing,' replied the husband. 'Yes,' she commented, 'in the . . .'" but the rest is too feeble to bear removing. The analysis would result in showing how the inventor of this elaborate witticism said to himself: "Go to—I will make me a joke! What word shall I try to play on? I will think over the poetry of my childhood, and choose me a word from it. 'Who killed cock robin?' Let me see—'robin' sounds near enough to 'robbing' to do. A cock robbing—um, um, um!—a cock stealing—a hen stealing. Why, there it is! Bring a hen stealing and a cock robbing into the compass of three or four lines, and the public (that is, the public *we* write for) will find that a full-sized joke." *Hinc illæ lacrymæ.*

AT that rate a man of average industry (and with a dictionary, *bien entendu*) will make you his hundred or so of such jokes *per diem*. But *Punch* ought to have nothing to say to such rubbish. The memory of writers like Hood, Jerrold, Thackeray, and Dickens should save the pages of our still leading comic paper from this dreary nonsense. Better than this would be even the ghastliest form of American fun—as suggestive of true humour as a grinning skull of cheerfulness.

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A CORRESPONDENT expresses annoyance because I have not hitherto answered in "Gossip" his question, Whether the 21st or 22nd of June is actually the longest day—especially as he had already asked that question in the anteroom of a place where I had lectured. I remember the occasion, and that I reached my hotel half an hour later than I had hoped in consequence; but I fail to see why this should lead me to resume the ungrateful task of answering correspondents in KNOWLEDGE. I may repeat, however, what I then laboriously explained, that the longest day is not the same in every year. That day on which the sun enters the sign Cancer is the longest day. I prepared my "Seasons Pictured," KNOWLEDGE LIBRARY, precisely to answer such questions; and when I consider how much labour I devoted to that work, and that it cost me something to get it printed and published, I venture to think that any one really interested in such matters might be willing to obtain the book, or to seek the information from others. It is a simple matter of fact that, if I answered all such queries as are thus addressed me, I could do nothing else. One might as reasonably ask a tailor for specimen suits as a student of science for letters of explanation.

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I KNOW not how it may be with others, but I find myself strangely moved by photographic records of the heavenly bodies. To see on a small area of photographic film the ripple marks of light waves which have travelled across the illimitable depths of interstellar space, taking years or centuries on their way, to close their career by writing down their record for the astronomers on our tiny earth—this, surely, is among the most amazing, one may almost say the most moving, achievements of the science of our day.

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BUT some of the recent triumphs of photography in this direction are, to my mind, even more striking, when rightly apprehended. The photographic charts, for example, in this number and our last, at first view seem in no way more striking than one of the charts of stars formed by Argelander and his assistants. One would say they were ordinary engravings showing a great number of stars, some of them large, others of medium size, others exceedingly minute. One might even say, how neatly has the engraver rounded these tiny discs! and how carefully he has shown the smallest stars by the minutest conceivable dots!—less than mere pin holes!

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BUT in reality every one of the white dots on the black ground has been engraved by the light waves of the corresponding star—aided afterwards by the stronger light of our own star, the sun. For, after the stars in a certain rich region had recorded their positions on a photographic film, and by solar action a positive had been formed from the resulting negative, a zincographic plate had to be formed from this star-drawn and sun-reversed chart. To do this the sun's rays were again called in to help the work of his brother suns, the stars, in that photographic field. On a film of gelatine his record of their positions was left, and afterwards certain acids poured on the gelatine film passed

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through where the star images were, to a zinc plate, whose surface they cut into after their characteristic manner.

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THUS was an engraving formed by the action of the stars and our sun alone—or, remembering that our sun is himself a star, we may say that the zincographic plate from which the chart was printed, was the work of the stars only! No human hand has touched the disc-shaped hollows by which each individual star has recorded its place.

PHOTOGRAPHIC STUDY OF STELLAR SPECTRA.

HENRY DRAPER MEMORIAL.

THE study of stellar spectra by means of photography was one of the most important investigations undertaken by the late Prof. Henry Draper. He was actively engaged in this research during the last years of his life. His plans included an extensive investigation, one object of which was to catalogue and classify the stars by their spectra. Mrs. Henry Draper has made provision, at the observatory of Harvard College, for continuing these researches as a memorial to her husband. The results already obtained, with the aid of an appropriation from the Bache Fund, permit the form of the new investigation to be definitely stated. The part of the sky to be surveyed is that extending from the North Pole to the parallel of 30 degrees south declination. Each photograph will be exposed for about one hour, and will include a region 10 degrees square. The telescope employed has an aperture of 20 centimètres (8 inches), and a focal length of 117 centimètres (44 inches). The object-glass is covered by a prism, and the resulting spectrum of each star in the region photographed has a length of about 1 centimètre, which enables the character of the spectra of stars from the fifth to the eighth magnitude to be determined. A modification of the apparatus is employed for the brighter stars.

Meanwhile experiments are in progress with the 15-inch equatorial, with the object of representing the spectra of some typical stars upon a large scale. The spectra so far obtained are about 6 centimètres in length, and exhibit much well-defined detail. Additional experiments will be tried with a spectroscope provided with a slit, as well as with the simple prism hitherto employed, in order to secure the best possible definition. The present results encourage the expectation that the movements of stars in the line of sight may be better determined by the photographic method than by direct observations.

To keep the astronomical public informed of the progress made in this work, specimens of the photographs obtained will be gratuitously distributed from time to time. The first of these distributions will probably be made in a few weeks. Owing to the expense of providing a large number of copies, it is desirable to limit the distribution, so far as possible, to those who are interested in this class of work. It is also desired, however, to send the specimens to all who will find them of value from the scientific point of view. A blank form of request is attached to the present circular, and may be filled out and sent to the Harvard College Observatory by any one desirous of receiving the specimens, but requests to the same effect in any form which may be convenient will also be cheerfully complied with so far as may prove practicable.

EDWARD C. PICKERING,
Director of Harvard College Observatory.
CAMBRIDGE, U.S., March 20, 1886.

THEOLOGY AS SCIENCE.—I conceive that the origin, the growth, the decline, and the fall of those speculations respecting the existence, the powers, and the dispositions of beings analogous to men, but more or less devoid of corporeal qualities, which may be broadly included under the head of theology, are phenomena the study of which legitimately falls within the province of the anthropologist. With theology as a code of dogmas which are to be believed, or at any rate repeated, under penalty of present or future punishment, or as a storehouse of anæsthetics for those who find the pains of life too hard to bear, I have nothing to do; and, so far as it may be possible, I shall avoid the expression of any opinion as to the objective truth or falsehood of the systems of theological speculation of which I may find occasion to speak. From my present point of view, theology is regarded as a natural product of the operations of the human mind, under the conditions of its existence, just as any other branch of science, or the arts of architecture, or music, or painting are such products. Like them, theology has a history. Like them also, it is to be met with in certain simple and rudimentary forms; and these can be connected by a multitude of gradations, which exist or have existed among people of various ages and races, with the most highly developed theologies of past and present times. It is not my object to interfere, even in the slightest degree, with beliefs which anybody holds sacred; or to alter the conviction of any one who is of opinion that, in dealing with theology, we ought to be guided by considerations different from those which would be thought appropriate if the problem lay in the province of chemistry or of mineralogy. And if people of these ways of thinking choose to read beyond the present paragraph, the responsibility for meeting with anything they may dislike rests with them and not with me.—*Professor Huxley in the "Nineteenth Century."*

JEWISH THEOLOGY.—We are all likely to be more familiar with the theological history of the Israelites than with that of any other nation. We may therefore fitly make it the first object of our studies; and it will be convenient to commence with that period which lies between the invasion of Canaan and the early days of the monarchy, and answers to the eleventh and twelfth centuries B.C. or thereabouts. The evidence on which any conclusion as to the nature of Israelitic theology in those days must be based is wholly contained in the Hebrew Scriptures—an agglomeration of documents which certainly belong to very different ages, but of the exact dates and authorship of any one of which (except perhaps one or two of the prophetical writings) there is no evidence, either internal or external, so far as I can discover, of such a nature as to justify more than a confession of ignorance or, at most, an approximate conclusion. In this venerable record of ancient life, miscalled a book, when it is really a library comparable to a selection of works from English literature between the times of Beda and those of Milton, we have the stratified deposits (often confused and even with their natural order inverted) left by the stream of the intellectual and moral life of Israel during many centuries. Imbedded in these strata, there are numerous remains of forms of thought which once lived, and which, though often unfortunately mere fragments, are of priceless value to the anthropologist. Our task is to rescue these from their relatively unimportant surroundings, and by careful comparison with existing forms of theology to make the dead world which they record live again. In other words, our problem is palæontological, and the method pursued must be the same as that employed in dealing with other fossil remains.—*Professor Huxley in the "Nineteenth Century."*

New Books to be Read (or avoided)—and Why.

Donovan: A Modern Englishman. By EDNA LYALL. (London: Hurst & Blackett.)—From the first page, with its impossible school scene, to the last chapter, with its preposterous change of a freethinking but semi-idiotic card-sharper into a believer in all the details of a specific religion, this book is a collection of absurd incongruities. Except for the scene of the death of Donovan's little sister, there is nothing in the story in which a full-grown mind can take interest. A schoolgirl's ideas of what a freethinker might be, of the ways and manners of card-sharpers, of the possible iniquities of designing relatives, of the method of training for the medical profession, and so forth, may be curious, and are certainly amusing; but they can hardly be interesting. This book will be attractive to those who imagine free-thought to be a sort of wild rebellion of mind against all that is sweet and lovely and goody-goody; just as the same class of mind delights in recognising such methods of reconciliation—save the mark!—as Mr. Drummond has tried to arrange between the tenets of a prevalent form of dogmatic religion and the doctrines of science. We are drawing no parallel, we need hardly say, between the mystical imaginings of Mr. Drummond and the incoherent absurdities of the young lady who writes under the assumed name of Edna Lyall. But such books are attractive to the same class of readers, and for the same reason. They supply the same (to them) satisfactory answer to their touchingly pathetic question, "Oh, *why* won't thinking men still accept with childlike blandness the sweet teachings of the pastors of their boyhood?" For grown folk such books are about as suitable as a diet of pap would be for the pioneers of a continent.

Dictionary of National Biography. Edited by LESLIE STEPHEN. Vol. VI.—Bottomley-Browell. (London: Smith, Elder, & Co. 1886.)—Mr. Leslie Stephen's noble undertaking, which cannot fail hereafter to rank among our British classics, shows no falling off either in its matter or manner. The present volume exhibits the same catholicity of selection and the same judgment in the treatment of the biographies of which it is composed that have distinguished its predecessors. Concise where the limited interest of its subject demands conciseness, and fuller and more rich in details where fulness is called for, these lives are the very models of what they should be. The man of science will here find all that he needs to know concerning Boulton (Watt's partner); Bourne, the mathematician; Boyle, the chemist; Bradley, the third Astronomer Royal, whose biography by Miss A. M. Clerke is really admirably written; Brande, the chemist; Briggs, the first computer of logarithms to the base 10; Brindley, the engineer; Sir T. M. Brisbane, the astronomer; T. A. Brown, the meteorologist, &c. &c.; while the lives of Alderman Boydell, the printseller of our great-grandfathers' days; Brassey, the contractor; and that of Lord Brougham, of whom it was sarcastically said that "if he only knew a little law he would know a little of everything," illustrate that catholicity of selection of which we have spoken above. No library of reference can in future be held to be complete which does not possess this *magnum opus* of Mr. Stephen.

Accounts of the Gypsies of India. Collected and Edited by DAVID MCRITCHIE. (London: Kegan Paul, Trench, & Co. 1886.)—To every one who has either served or been permanently resident in India the words "gypsies of India" will call up the reminiscence of the race of Bunjáras, who are partly carriers, partly poachers, and wholly thieves, and who, with their long strings of pack-bullocks, their complexion—dark even for India—and their bizarre costume, form so picturesque a race of vagabonds. The author of the first part of the most curiously miscellaneous work before us, Professor de Goeje, however, applies the term Zotts, or Jauts, to the tribes which he seems to regard as the Indian gypsies, and in which he includes certain jugglers, bearleaders, and the like. He apparently considers these Jauts as descended lineally from the Medes. It would seem as though M. de Goeje's acquaintance with India were limited to the North-West Provinces. His text is illustrated—or contradicted, as the case may be—by numerous notes in an appendix furnished by Mr. McRitchie. Then the siege of Bhurtpoor is lugged in, for no other reason that we can discover than that the defenders of that famous fortress were Jauts. Two chapters on "Remarks on certain Gypsy Characteristics" and "Miscellaneous Remarks" complete the volume. That matter of interest is enshrined in it we are not concerned to deny; but on rising from its perusal we feel that its prevailing characteristic will be best expressed in the words of the Scottish idiot, who, having read a dictionary through from beginning to end, closed it with the remark that "it was a vair' disconnectit buik."

British Petography. By J. J. HARRIS TEALL, M.A., F.G.S. Parts II. and III. (Birmingham: Watson Brothers & Douglas.)—Petography, or the study of the intimate structure of rocks, almost owes its being in its existing form to Mr. Sorby, whose masterly microscopical researches have placed this indispensable adjunct to the knowledge of the field geologist upon a truly scientific basis. Mr. Teall, in the carefully executed work before us, accurately describes the minute structure of the different rocks of which he treats, and amply illustrates such description by capitally executed chromo-lithographs from slides of the rocks themselves as seen under the microscope, both by ordinary and polarised light. Woodcuts, too, illustrating peculiarities of structure, are scattered through the text. The nature of the minerals and the mode of their inclusion in rock masses, often throws a welcome light upon the method of their original formation; and, viewed in this relation, Mr. Teall's book will be found valuable to all engaged in the work of personal examination of the materials forming the earth's crust.

The Rotifera or Wheel Animalcules. By C. T. HUDSON, LL.D. Cantab, assisted by P. H. GOSSE, F.R.S. Parts II. and III. (London: Longmans, Green, & Co. 1886.)—If, on being introduced to a stranger, we were suddenly to see his face begin to rotate about an axis passing horizontally through his nose, we could scarcely behold so surprising a spectacle with more blank amazement than did old Leeuwenhoek feel when, towards the end of the seventeenth century, he obtained his first sight of the wheel animalcule under his microscope. For, with the optical means at his disposal (and, in fact, with more refined apparatus still), the effect of a creature the lobes of whose head were seemingly rapidly turning round like toothed wheels, might fairly cause any observer to doubt the evidence of his own senses. And in this particular case the doubt would have been wholly justifiable, inasmuch as we now know this effect of seeming rotation to be an optical illusion, having its origin in the motion of innumerable "cilia" fringing the discs which form the head of the creature, and producing a deception akin to that caused by the revolving cups of an anemometer, the Zoëtrope, &c. &c. As we have not seen the first part of

Dr. Hudson and Mr. Gosse's magnificent work, we are ignorant of the particular form of rotifer which they select as their typical one; but, for our present purpose, we may take that very common one, the Rotifer vulgaris, and ask the reader, who approaches the consideration of this subject for the first time, to picture to himself an aquatic animal allied to a worm, having a transparent body about one-fiftieth of an inch in length. It has two small round red eyes, two teeth (whose constant movement in triturating the food swallowed by the creature was mistaken by Leeuwenhoek for the pulsations of its heart!), a stomach, with surrounding gastric glands, a contractile vesicle, and a nervous system, a triangular ganglion of which serves the rotifer for a brain. The variety of form, however, in this marvellous group of creatures is almost inexhaustible, and as far as their external appearance is concerned, numbers of them have scarcely anything in common save the trochal disc, or wheel organ, and even that assumes the most diverse forms in various genera and species (e.g. Synchæta and Stephanoceros). Our authors have addressed themselves to the description and illustration of the entire class of these strange organisms, and most admirably and thoroughly are they performing their task. Of the correctness and beauty of the illustrations it would be impossible to speak in too high terms. We are stating a very plain and sober truth when we say that, for the purposes of the student, they are perfect. Every microscopist at a loss for a most interesting employment of his instrument, alike with every student of biology and zoology, should procure this superb book. In fact, a microscopical library is as incomplete without it as would an ordinary one on whose shelves neither the Bible nor Shakespeare found a place.

A Short Manual of Chemistry. Vol. I., Inorganic Chemistry. By A. DUPRÉ, Ph.D., F.R.S., &c., and H. WILSON HAKE, Ph.D., F.C.S., &c. (London: Chas. Griffin & Co. 1886.)—The conspicuous merit of this treatise on chemistry by Drs. Dupré and Hake is that it begins at the very beginning, and takes no preliminary knowledge whatever for granted on the part of the student. The introductory chapters are particularly good, and the information generally brought down to the very latest date.

Arithmetic for Schools. By the Rev. J. B. LOCK, M.A. (London: Macmillan & Co. 1886.)—Mr. Lock very wisely avoids crowding his book with rules, and gives examples worked out at length instead, The theory of the operation to be performed is, however, always stated. He has obviously taken immense pains with this work, which seems well adapted to the purpose for which it was designed.

The Elements of Economics. By HENRY DUNNING MACLEOD, M.A. In two vols.—Vol. I. (London: Longmans, Green, & Co. 1881.)—There is a species of superstition, more or less widely diffused, that with the universal establishment of Free Trade, political economy would practically cease to have any *raison d'être*; but, as Mr. Macleod points out in the masterly work before us, this amounts to regarding the science of economics as simply a destructive one, and ignoring it altogether in its constructive or positive aspect. No one could or would for an instant deny the yeoman's service rendered to economical science in the past by such representative men as Adam Smith, Ricardo, and John Stuart Mill, but in many material respects they stood much in the same relation to the more scientific economists of the present day as Stahl with his "Phlogiston" did to Priestley and his successors. In reviewing the second volume of the work now before us, on p. 192, we expressed the opinion that "if the previous portion of the book before us is as sound in its inferences and apposite in its illustrations as the one before us, it, as a whole, constitutes a valuable and important contribution to economical science;" and we are happy to find, on perusing the first volume, that our hypothetical estimate of its value is thoroughly justified. A ripe scholar, possessing information of the most varied and extensive character, and an enthusiastic admirer of the Baconian philosophy, Mr. Macleod has employed the inductive method to build up a system of economics which must render his book a classic, be the future developments of the science what they may. His originality and wealth of illustration render his volumes readable even by those to whom their title conveys little beyond the idea that they must treat of a very dry subject. Anyone possessed by such a notion who will open them will find himself agreeably disappointed.

Coffee: Its Cultivation and Profit. By EDWIN LESTER ARNOLD. (London: W. B. Whittingham & Co. 1886.)—At a time when coffee-planting in Ceylon spells "periodical bankruptcy," a book on the "Cultivation and Profit" of what was at one time the staple of the classical Taprobane may well appear, at the first blush, superfluous. Mr. Arnold, however, points out in the eminently practical work before us that a vast area of heretofore uncultivated land is in existence upon which coffee could be grown at a handsome profit, and in his concluding chapter on "Coffee Countries" he shows over how wide an area of the earth's surface remunerative crops of this valuable plant might be grown. The minute and explicit directions for coffee culture, which form the main portion of the volume, are obviously the work of an expert whose personal experience embraces the most recent methods of cultivation and curing. Coffee-planters who wish to make the most of their existing estates will certainly buy the book; while it may, further, be commended to adventurous young men in search of a pleasant and healthy occupation.

Gesta Christi: a History of Human Progress under Christianity. By C. LORING BRACE. (London: Hodder & Stoughton.)—By gathering all the progress of humanity during the last eighteen centuries to Christianity, and all religious hatreds and persecutions to the Church, Mr. Brace seems to make out a very strong case. The Catholic Church seems to make out an even stronger case when attributing all progress to the Church and all evil to freedom of inquiry. Science, did she care for it, might make out a much stronger case than either—a case, also, really not apparently strong—by showing the actual nature of progress among the Indo-European races during the last 2,500 years.

James Nasmyth, Engineer: An Autobiography. Edited by SAMUEL SMILES. New Edition. (London: John Murray.)—We are glad to see a new and cheaper edition of this most interesting and instructive work. There is more real religion in the life of such a man as Nasmyth than in the lives of a thousand dreaming, hysteric "saints." We shall have occasion to make further reference to this valuable book before long.

Modern Whist. By CLEMENT DAVIES. (London: Sampson Low, Marston, & Co.)—This little treatise on whist is reserved for review by "Five of Clubs." It should be good to justify its price. We have here a work of 96 pages, whereof all but 41 either belong to title, preface, and the laws (quoted *verbatim*), or are blank; the 41 pages of original matter average 170 words per page. The price of the book is four shillings. Comparing this with the contents and price of "Cavendish," and still more with those of "How to Play Whist," by "Five of Clubs," it will be seen

that Mr. Davies thinks that a very little of his whist will go a long way. In "Home Whist," by "Five of Clubs," there are 80 pages, of which 72, averaging 230 words, are occupied with original matter. It would thus appear that "Five of Clubs" considers one shilling a fair price for 16,000 words of original matter, while Mr. Davies values at four shillings 7,000 words of original matter *plus* about as many words of matter which Clay, Cavendish, Pole, Drayson, and others, have already thrown into their works almost for nothing.

Trigonometry for Beginners. By J. B. LOCK. (London: Macmillan & Co.)—A capital little book, thoroughly sensible and practical. It extends only to the solution of triangles, a very proper limitation.

The Definitions of Euclid, with Explanations and Examples. By R. WEBB. (London: George Bell & Sons.)—A simple and suggestive study of the definitions. A student who has thoroughly mastered the subject-matter of this treatise will find the study of the problems much simplified for him.

Class-Book of Geology. By ARCHIBALD GEIKIE. (London: Macmillan & Co.)—This is a book which we hope to review in full ere long (in company with the book next mentioned). But we must not delay recognition of its great value. We know of no work giving a clearer or more impressive idea of the history of the Earth as recorded in her crust. Professor Geikie's descriptive style is simply perfect.

Outlines of Geology. By JAMES GEIKIE. (London: Edward Stanford.)—Fuller in details, this work of Professor Geikie's is but little inferior in literary excellence to his brother's admirable work. It serves as a convenient middle step between that book and Professor A. Geikie's larger treatise, already noticed in these columns.

Mythical Monsters. By CHARLES GOULD. (London: W. H. Allen & Co.)—A capital book, showing that many monsters regarded as mythical are in reality not mythical at all. We propose to give a full review of this most interesting work in an early number.

Flowers, Fruits, and Leaves. By Sir J. LUBBOCK. (London: Macmillan and Co.)—A charmingly written and well illustrated little work, showing the origin by evolution of many of those wonderful "evidences of design" on which the theologians of a century ago were so fond of dilating—limited knowledge enabling them to imagine but one interpretation. Sir J. Lubbock writing about science is a very different man from Sir J. Lubbock on a hundred books.

The Springs of Conduct: An Essay on Evolution. By C. LLOYD MORGAN. (London: Kegan Paul & Co.)—An excellent and most interesting exposition of the growing doctrine of the evolution of conduct. Reserved for fuller review when space permits, which will be soon.

Lewis's Pocket Medical Vocabulary. (London: H. K. Lewis. 1886.)—Mr. Lewis's little book will be found useful, not only by the medical practitioner, but also by all engaged in the administration of those branches of the criminal law into which medico-legal questions enter. In fact, it will even be found handy by that numerous class which revels in the reports of murder-trials and of coroners' inquests in the daily papers, by adding to its appreciation of the meaning of much of the seeming jargon which appears as evidence. At once full and concise, we have but one trivial fault to find with the work before us. It is that its compiler is here and there somewhat hazy in his "quantities." For example, he speaks of Ab'domen, the correct pronunciation being Abdo'men. In the same way we find Ver'tigo for Verti'go—and so on. The classical reader will of course correct all this for himself.

The Legal Guide for Landlords, Tenants, and Lodgers. By J. T. AKERMAN, Esq. (London: Griffith, Farran, Okeden, & Welsh.)—This is a pamphlet whose value is out of all proportion to its very small price and unpretending aspect. It contains, in a compendious form, everything that need be known by a layman on the subject of the relations existing between the landlord and his tenant; and no one should either let or take a house, furnished or unfurnished, or even lodgings, without a careful study of the law as simply laid down in a manual as cheap as it is sound.

The Tourist's Guide to the Flora of the Alps. By PROFESSOR K. W. v. DALLA-TORRE. Translated and Edited by ALFRED W. BENNETT, M.A., B.Sc. (London: Swan Sonnenschein, Le Bas and Lowrey. 1886.)—This admirably compact work, in its form of a tuck pocket-book, will be found invaluable by the botanist and plant-collector in the Alps. Carried easily in one of the smaller pockets of a shooting-coat, and most conveniently arranged for reference, it is the very book for everyone for whom the strange Alpine flora possesses any charm. To all such we commend it.

Latin Prose Composition. By the Rev. HERBERT W. SNEYD-KYNNERSLEY, LL D. (London: Relfe Brothers.)—This is one of the innumerable successors to the "Ellis's Exercises" of our childhood. Dr. Kynnersley seems to have done his work conscientiously and selected his examples judiciously.

Walford's Antiquarian. Edited by EDWARD WALFORD, M.A. April 1886. (London: George Medway.)—All who delight to live in the memories of the past should read Mr. Walford's charmingly chatty magazine, which brings pleasantly before us so much that is good, beautiful, amusing, and interesting in times long separated from our own.

The Vegetable Garden. By MM. VILMORIN-ANDRIEUX, of Paris. English Edition, published under the direction of W. Robinson, Editor of "The Garden." (London: John Murray. 1885.)—Assuredly there is no such an encyclopædia of esculent vegetables in existence as the exhaustive one whose title heads this notice; containing, as it does, admirably executed drawings and full descriptions of every garden vegetable used for the food of man in temperate climates, together with explicit directions for its cultivation. To the gardener, be he professional or amateur, to the gourmand, and very notably to the vegetarian, MM. Vilmorin-Andrieux's book is simply indispensable; while the general reader will learn with some amazement from its pages how numerous and delicious are the plants grown for the table, of whose very names he has previously been in ignorance. Our authors have conferred a real service upon all who are anxious for variety in their diet, as well as upon those to whom we have to look for its production.

The Artist's Manual of Pigments, by H. C. STANDAGE (London: Crosby Lockwood & Co. 1886), is a book calculated to be of the greatest possible service to all artists, and more especially to those just beginning their career, and to art students. The deterioration in hue of modern

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pictures as compared with those of the old masters is very apparent even to the unprofessional eye, and the reason of this is to be found in the fact that most modern painters are ignorant of the chemical composition and reactions of the pigments they employ, and therefore not only use impure pigments adulterated by the trade, and sold to supply the demand for cheap materials, but also make dangerous immixtures of pigments and vehicles, so that their pictures become in reality self-destructive. In his present valuable little work Mr. Standage gives the chemical name and composition of each pigment, with particulars as to its artistic use, the conditions under which it is permanent or non-permanent, the general adulterations and the tests for the discovery of these, and adds a most useful chapter on reactions between two or more pigments and between pigment and vehicle, &c. Another chapter is on mixtures of pigments, to produce various colours; and he also gives very good advice as to the respective value of different pigments for use in portrait, flower, and marine paintings. The remarks made in Chapter VIII. as to the necessity of making a scientific nomenclature and scales of colour are very much to the point. When we come to define a tint or colour, we are almost invariably at a loss for words, and some convention should certainly be made on this important subject. The matter should be taken up by the Royal Society or the Society of Arts, and Mr. Standage's suggestion that the hues of well-known fruits or flowers should be taken to form the foundations of scales of colour is a very feasible one.

Dogs, in Health and Disease, as Typified by the Greyhound. By JOHN SUTCLIFFE HURNDALL, M.R.C.V.S. (London: E. Gould & Son. 1886.)—The medical system advocated in this work is homœopathic, and very full and explicit directions for the treatment of every canine ailment on that system are given by Mr. Hurndall. Whether agreeing with the doctrine of Hahnemann or not, the dog-owner may, however, glean some useful information from these pages, as it is pretty obvious that the author has entered deeply into the question of canine pathology, and has an intimate personal acquaintance with the various types of disease which afflict man's faithful companion.

The "Competitive Examination Papers" in Pure Mathematics (Stages I.–III.). By N. C. POTTER. (London: Moffatt & Paige.)—Loaded up to the muzzle, like an overcharged gun, and then let off at his "exam.," the miserable competitor but too often quits the examination room as empty as the discharged gun to which we have likened him. Just so long, however, as the present system exists will the miserable system of cramming survive too; and if we are to admit the necessity of the evil, Mr. Potter's little book will enable the student to fill his mind effectually with the kind of "knowledge" which passes muster in Cannon Row and at South Kensington.

Bemrose's New Code Drawing Cards, Second and Third Series. (London: Bemrose and Sons.)—These cards contain "copies" for students, the first set curved forms for free-hand drawing, and the second geometrical figures. They fulfil the requirements of the "Science and Art Department," which is presumably what they are intended for.

A Manual of Mechanics. By T. M. GOODEVE, M.A. (London: Longmans, Green, & Co. 1886.)—In simple language and formulæ, illustrated by equally simple examples, Mr. Goodeve introduces the beginner to the elements of mechanical philosophy. As may be expected from so thorough a master of his subject, nothing is omitted which will smooth the path of the young student; who is led on step by step until, with the most moderate attention on his part, he possesses a competent knowledge of the elements of applied mechanics, and is in a position to attack works of a higher and more pretentious character. This is a capital little book.

Notes on School Management. By GEORGE COLLINS. (London: Moffatt & Paige. 1886.)—Mr. Collins's book will be found useful by teachers in public elementary schools, as also by the managers of such schools; in fact, by all interested in elementary education. It contains a large quantity of well-arranged information.

AN OLD MISTAKE CORRECTED BY MODERN SCIENCE.—While Science is quite unable to say definitely the order in which the several races actually *began*, she is able to say most positively that these several races did not *come into existence as races* in any order whatsoever. Not to consider for a moment the absolutely overwhelming argument when mammals are compared with, say, reptiles, or vertebrates with insects, or either with molluscs, and to put on one side the still more crushing argument from the comparison of animal with vegetable life, take the case of two existent species—men and horses. Science cannot determine whether man came before the horse, or even say where, along the lines of development from anthropoid apes to man on the one hand or from the Eohippus to the horse of to-day on the other, it could truly be said that man or horse had actually appeared on the earth. But science can say most positively that neither did the development of the horse precede that of man, nor, *vice versâ*, did the development of man precede that of the horse. Both developments went on together—this being no theory, but the direct teaching of the records contained in the later tertiary and earlier quaternary strata of the earth. The very natural mistake of the old Babylonian folk, which quite as naturally their much less intelligent Jewish captives were not able to detect and correct, lay in supposing that not merely whole species, but whole *genera*, were formed at once, each being fully completed before the next took its turn. Whether the completion of each required a day of twenty-fours hours, as theologians once taught, or a period of indefinite length, as they are good enough to assume now (being obliged), this mistake shows that those who made and maintained it really knew nothing about the origin of life, animal and vegetable, upon this earth. As, indeed, how *should* they? What an absurdity it is, if we come to think of it, to make our interest in the old Hebrew writings depend in the slightest degree on the question whether the old Accadians, to whom the earliest records in the cuneiform inscriptions were due, really knew what it has taken modern races, who have specially devoted themselves to the inquiry, many centuries of research to ascertain!

M. RENAN AND THE BIBLE.—What M. Renan has said with regard to the literature of the ancient Hebrews (considered by them, and accepted by other than Hebrew races, as sacred) is fair enough when he is considering its history. He points out clearly, for instance, what every competent judge must notice, that some books are altogether inferior to the rest, and even "mere *réchauffés*, very unintelligently done, from the ancient histories." This description applies in particular to the two books of Chronicles, as any one will find who carefully compares these with the corresponding parts of the books of Samuel and of Kings. The books of Ezra and Nehemiah show similar shortcomings. But in dealing with ancient literature as a whole, M. Renan is unfair to modern literature in regarding the Hebrew and the Hellenic literatures as the two sole "sources of unconscious and impersonal beauty" for the world. "The literary history of the world," he says, "is the history of a double current, which has descended on the one side from Homer to Virgil, on the other from the Hebrew Bible to Jesus. Since then we have lived upon them." If this is meant only in the same sort of sense as—for example—one might say "Newton owed all the scientific power which has made his name illustrious to his father and mother," one need take no exception to the remark. A Shakspeare and a Goethe may be the mental offspring of the Aryan and Hebrew stocks of poetry. But M. Renan's words imply much more than this. They suggest that in his opinion the literature of modern times (i.e. of times since Virgil and Jesus) has been no more than a re-working of the material collected by the older writers—the Isaiahs, Jeremiahs, Hesiods, and Homers, of old races. This is not only a paradox, but a most perverse one.—*Newcastle Chronicle.*

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MEASUREMENT OF STELLAR LUSTRE.*

THE *Uranometria Nova Oxoniensis* is a valuable work, though not equal in accuracy to the admirable survey by Professor Pickering. The method adopted by Professor Pritchard is indeed not susceptible of exact accuracy, though sufficiently accurate for the purpose in view. Seventy thousand instrumental measures were made with the wedge photometer by Messrs. Plummer and Jenkins, the real authors of this excellent work, and all stars visible to the naked eye, from the North Pole to ten degrees south of the equator, are included in the survey. The title-page bears the name of Professor Pritchard, who is supposed to have overlooked the work, and who certainly overlooked certain serious defects in the method of observation. These, however, have been sufficiently indicated by Professor Pickering, whose more numerous and exact observations, actually conducted by himself personally, make his opinion authoritative in such matters. No astronomical library would be complete, however, without the excellent work containing the results of the survey of the northern heavens by Messrs. Plummer and Jenkins.

MR. RUSKIN ON THE BIBLE.—Mr. Ruskin has written the following letter, as his rather questionable tribute to the literature of the ancient Hebrews:

St. Mark's Day, 1886 (Easter Sunday).

Sir,—Will you allow me, rather from Venice, in thought, than from poor little Brantwood, in body, to send you one quite serious word, for the close of my part in your book discussion? I see in your columns, as in other literary journals, more and more buzzing and fussing about what M. Renan has found the Bible to be, or Mr. Huxley not to be, or the bishops that it might be, or the School Board that it must not be, &c. Let me tell your readers who care to know, in the fewest possible words, what it is. It is the grandest group of writings existent in the rational world, put into the grandest language of the rational world in the first strength of the Christian faith, by an entirely wise and kind † saint, St. Jerome; translated afterwards with beauty and felicity into every language of the Christian world; and the guide, since so translated, of all the arts and acts of that world which have been noble, fortunate, and happy. And by consultation of it honestly—on any serious business, you may always learn—a long while before your Parliament finds out—what you should do in such business, and be directed perhaps besides to work more serious than you had thought of. For instance, I meant this morning only to have written some autobiography, but as it was St. Mark's Day, reading his first chapter, it struck me, if perchance anybody in this pious nation—proposing this year to effect sundry changes in its hitherto all-vaunted constitution—wished in their Easter holidays to baptise themselves, confessing their sins, and abjuring them in a cheerful and hopeful manner—what sort of streams could they find to baptise themselves in near most country towns? I observe, sir, you have complimented our—for the time reposing—Parliament on its hitherto devotion to business. I have not myself noticed much that it has done to any purpose, except virtually abolishing the Act against pollution of rivers. Which repentance of theirs virtually signifies that the management of the millennium we have presently to look for is to be put in the hands of the sort of British patriot who is ready to poison the air, and the wells, for his neighbours, a hundred miles round, and to sit himself all his life up to his throat in a—[really Mr. Ruskin indulges in somewhat strange illustrations, and in his Biblical enthusiasm uses words unpleasing to ears polite], so only that he may lick up lucre from the bottom of it.

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* *Uranometria Nova Oxoniensis.* A photometric survey of the stars visible to the naked eye at Oxford, carried out at the Oxford University Observatory, by Messrs. W. E. Plummer and C. Jenkins. By [?] Professor Chas. Pritchard. London: H. Frowde.

† As a sample of the saint's kindly wisdom, one may quote from his letter to Marcella; where, speaking of those who objected to his correction of words in the Gospels, he says, "I could afford to despise the poor creatures (*homunculos*); for a lyre is played in vain to an ass." Jerome's kindness was akin to Mr. Ruskin's modesty.

THE FACE OF THE SKY FOR JUNE.

By F.R.A.S.

THE sun may still be examined, as occasion offers, for spots and faculæ. Map vi. of "The Stars in their Seasons" gives a representation of the night sky. In one sense, however, there is no real night in any part of the United Kingdom during the month of June, inasmuch as twilight persists from sunset to sunrise. Mercury, as a morning star, is poorly placed for the observer during the first part of June, in fact, he comes into superior conjunction with the sun—or is, so to speak, behind him—at 2 A.M. on the 12th. After this, though, he becomes an evening star, and towards the end of the month may be seen with the naked eye twinkling like a star of the 1st magnitude over the W.N.W. horizon. Venus is a morning star throughout June, but is getting smaller daily, and her beautiful crescent has given place to a gibbous figure, which renders her a much less interesting object in the telescope. Mars is becoming an insignificant object, but may be seen in the west when it gets dark as a big red star. He travels from Leo into Virgo, and on the nights of the 22nd and 23rd will be just south of β Virginis ("The Stars in their Seasons," map v., or "The Seasons Pictured," plate xxv.) At 10 o'clock in the morning, on the 28th, Mars and Jupiter will be in conjunction. The minor planet Juno may now be picked up to the S.W. of η Serpentis at the beginning of the month, whence it travels towards ζ in the same constellation ("The Stars in their Seasons," map vii.) She looks like an orange-coloured star of the 8th magnitude. Pallas may be seen, too, as a yellowish 7th mag. star, very sharply defined. Towards the end of June she will be among some of the 6th mag. stars, in the south-eastern part of Hercules. Jupiter is getting towards the west, and must be looked at as soon as it is dusk. He is in "quadrature" or 90° removed from the sun at 10 A.M. on the 18th; and although he is at far too great a distance to exhibit phases or to look actually gibbous, as Mars does, yet a perceptible shading will be seen on his following limb. He is situated somewhat to the east and north of β Virginis, and travelling towards η ("The Stars in their Seasons," map v., or plate xxv. of "The Seasons Pictured"). Twilight &c. diminishes the number of fairly observable phenomena of his satellites, but enough remain to supply the student with some interesting work. To begin with, Satellite I. will be occulted on the night of the 1st at 11h. 36m. P.M. On the 2nd the shadow of this same satellite will enter on to Jupiter's face at 8h. 56m. P.M.; the satellite casting it will pass off Jupiter's opposite limb at 11h. 12m., and the shadow 25 minutes after midnight. On the 3rd, Satellite I. will reappear from eclipse at 9h. 31m. 27s.; and Satellite II. begin its transit at 11h. 51m. P.M. On the 5th, Satellite II. will reappear from eclipse at 12h. 13m. 26s. P.M. On the 9th, Satellite I. will enter on to Jupiter's face at 10h. 49m. The same satellite will reappear from eclipse on the 10th at 11h. 26m. 12s. P.M. On the 11th, Satellite III. will be eclipsed at 9h. 54m. 53s. P.M. On the 12th, Satellite II. will be occulted at 9h. 32m. On the 18th, Satellite III. will be occulted at 8h. 31m.; Satellite I. will pass off Jupiter's face at 9h. 29m., as will its shadow at 10h. 44m. P.M. Satellite IV. will be occulted at 10h. 10m. on the night of the 19th. On the 25th, the ingress of the shadow of Satellite I. will occur at 10h. 24m.; and lastly, on the 26th, Satellite I. itself will reappear from eclipse at 9h. 44m. 33s. P.M. Saturn and Neptune are both invisible, but Uranus may still be seen, as soon as ever it is dark enough, just south of η Virginis ("The Stars in their Seasons," map v., or "The Seasons Pictured," plate xxv.) The moon is new at 1h. 55·3m. P.M. on the 2nd; enters her first quarter at 7h. 26·7m. in the morning of the 9th; is full at 1h. 38·9m. in the early afternoon of the 16th, and enters her last quarter at 4h. 35m. P.M. on the 24th. Four occultations only, and those of small stars, are visible at tolerably convenient hours during the present month. On the 9th B. A. C. 4,043, a star of the 6½ mag. will disappear at her dark limb five minutes after midnight at an angle of 74° from her vertex. She will be setting at its reappearance. On the 19th, before she has risen B. A. C. 7,145 of the 6½ mag. will have been occulted by her bright limb. Later it will reappear at her dark limb at 10h. 18m. at a vertical angle of 186°. On the 20th B. A. C. 7,487 of the 6½ mag. will disappear at the bright limb at 12h. 36m. P.M. at an angle of 89° from the vertex of the moon. It will reappear at her dark limb at 1h. 55m. the next morning, at an angle of 258° from her vertex. Finally, on the night of the 23rd, 24 Piscium, a 6½ mag. star, will disappear at the moon's bright limb at 12h. 43m. at an angle from her vertex of 87°, reappearing at the dark limb at 1h. 47m. A.M. on the 24th, at a vertical angle of 241°. At noon to-day the moon is in Taurus ("The Seasons Pictured," plate xxiii.), through which

constellation she is travelling until 2h. 30m. P.M. on the 3rd, at which instant she crosses into the narrow northern strip of Orion. By 2 o'clock the next morning she has traversed this and entered Gemini ("The Seasons Pictured," plate xxiv.) Her passage across Gemini occupies her until 4 P.M. on the 5th; and then she passes into Cancer. At 3 A.M. on the 7th she quits Cancer for Leo; as she does Leo, in turn, for Virgo, at 3 P.M. on the 9th ("The Seasons Pictured," plate xxv.) By 5 P.M. on the 12th she has travelled across Virgo and passed into Libra ("The Seasons Pictured," plate xxvi.) Having completed her journey through Libra, at 3 P.M. on the 14th she arrives at the narrow northern strip of Scorpio. She takes 9 hours to cross this, and emerges in the southern part of Ophiuchus at midnight. On the 16th, at 7 P.M., she leaves Ophiuchus for Sagittarius; whence, at 8 A.M. on the 19th, she crosses into Capricornus. She leaves Capricornus for Aquarius at 7 A.M. on the 20th ("The Seasons Pictured," plate xxi.), her passage across Aquarius occupying her until noon on the 23rd, when she enters Pisces ("The Seasons Pictured," plate xxii.) She is occupied until 6 P.M. on the 26th in traversing this great constellation, and at the hour just named passes into Aries ("The Seasons Pictured," plate xxiii.) At 10 A.M. on the 28th she leaves Aries for Taurus. In pursuing her path through the last-named constellation she once more arrives, at 11h. 30m. on the night of the 30th, on the boundary of the narrow northern strip of Orion. She is, of course, in this outlying portion of Orion at midnight.

WHIST.

By "FIVE OF CLUBS."

IN the following sketch of a game we compare the way in which a scientific player and the old-fashioned family whist-player regard and deal with a particular hand. The question of the advantage or propriety of signalling does not come in; at any rate, nothing is gained by the only player who actually signals, but, on the contrary, he obviously loses ground through his signalling.

I am, let us suppose, the third player; my partner, therefore, having to lead. I find on examining my cards that I hold Queen and two small trumps (Clubs); King and three small cards in my best plain suit (Spades); Queen, Knave, and another card in another plain suit (Hearts); and in the remaining suit (Diamonds) I hold Ace and two small cards. The trump card is a small Club. This is a good hand, though many would be discontented with it, as there is nothing very striking in its strength. I am rather short, it is true, in trumps, and if my King falls in Spades I can do nothing in my best suit; but with fair luck in the fall of the cards, and if my partner has a tolerably good hand, we ought to be able to hold our own against the enemy, for I have a fair amount of protection in the other plain suits. Still, if the enemy are strong in trumps, and have a long and strong plain suit, matters may go rather heavily against us. That is the view which the player of whist takes of such a hand. The family whist-player, on the other hand, considers that he will surely make his Ace of Diamonds, and probably his King of Spades and one of his Queens, and there his ideas about such a hand stop.

Now suppose my partner leads the King of Diamonds: then I know he holds the Queen also, and most probably two more. If he only holds one more, probably he holds four trumps and three cards in each of the other suits. The player on my right drops the Nine; I and the fourth player two small cards. My partner leads the Seven of Diamonds, player on my right drops the Four, I play the Ace, and player on my left drops another small card; but the Six of Diamonds has not yet fallen. To the family whist-player holding such a hand as mine, and also playing as I have done (for he could do no otherwise), the game is no more developed now than it was at the beginning. He would be troubled about making his King of Spades, as he had already made his Ace of Diamonds; but would have no idea how the cards lay. But the game has in reality been much developed, and the proper strategy clearly indicated. I know, if I understand whist and have been duly observant, a number of things. In the first place, the player on my right is strong in trumps, for he has signalled his partner to lead them at the first opportunity. Next, I know that my partner has the Queen of Diamonds, and not *both* the Knave and the Six. If he is a follower of the new American rules he may hold the Six, and have played the Seven as his fourth best card; but in that case he does not hold the Knave, for, had he done so, the Knave (from five cards in the suit, headed by King, Queen, Knave) was the right card to play. The Six certainly does not lie on my right. The chances are that either the Six or the Ten, or the Knave, or both Six and Ten or Six and Knave, lie on my left. Therefore, if I lead my partner's suit, the chances are that I compel the player on my right to trump—my partner still remaining with the best card of the suit, and perhaps with both the remaining cards. Now this is precisely what the family whist-player would religiously avoid. "What! give my foe the chance of trumping!" he would say. "Most assuredly not, if I know it." He would lead his lowest Spade, the chances being two to one that the enemy would make the trick, bring in trumps, and probably make a number of tricks in Hearts, which are certainly their strong plain suit. The family whist-player would be quite unconscious that he had brought disaster on himself and on his ally by losing the chance of forcing the adverse strong trump hand.

I lead, however, my partner's suit; he heads the second player, and fourth player trumps. So much is certainly good for our side. Possibly that strong trump hand on my right may have been so far weakened that he will not now lead trumps. But it appears that this is not the case. He leads a small trump. I know now that either he originally held six, or else his plain cards are very strong, in which case I rejoice at the thought that my King of Spades lies on his left, for he probably holds the Ace. (As a matter of fact he does not, but that is a detail.) He leads a trump, then; I play a small trump; player on my left exhibits, luckily, extreme weakness—his card is the original trump card—and my partner takes the trick with the Ten. Now, what will my partner do? He knows not which is my better suit of the two plain suits unplayed. If he holds both the remaining cards of his own suit (Diamonds) he would hardly lead one; for that would be to let the weak trump hand ruff, and this is always bad. However, I find he does lead the best card of his suit. I have reason then to think that the last card of the suit lies with my enemy on the left. The case is really otherwise, and far more favourable for us. See, now, how the strong opponent is put at a disadvantage by this lead, which, to the family whist-player, seems so absurd. If he lets it pass, a trick is made, and probably the next lead will be through his strength—always unpleasant. If he trumps it, he either has to lead trumps again, which (after the weakness shown by his partner) is misery, or to lead from his strong suit at a probable disadvantage; for neither of his enemies has yet unguarded himself in either Spades or Hearts. He passes the trick. I discard a small Spade—following the proper course when the enemy has declared strength in trumps. But, aha! what is this? My opponent on the left neither follows suit nor trumps, but discards a Heart! This discloses nearly everything. I know not only that my partner holds the remaining Diamond—which is obvious, though the family whist-player, who will never condescend to count up to thirteen, might not have noticed it—but that he must hold such trumps as to have felt sure that the player on my left had no more. I know, further, that the other enemy cannot have held originally six, or he would have been well able to afford a ruff. Since, then, I held three, and the two opponents on my right and left five and one respectively, my partner held originally four trumps. We have our erst threatening foe, then, in a cleft stick! My partner equals him in length of trump suit in hand; I hold a guarded Queen in trumps, second best in Spades, and a high sequence in Hearts. We shall come out best, without question.

My partner now leads the last Diamond. Second player may please himself as to trumping it or passing it. If he trumps with anything short of his best (he does not hold *both* the Ace and the King, I know), I shall over-trump. He is in the dark as to the position of the high cards in trumps. He prefers not to disarm himself, lest haply he should lose in the play of the plain suits; for, observe, this is but the sixth trick. He passes the trick (I discarding a Heart). And now my partner, having good reason to think that it will be disadvantageous for second player to be led through in trumps, leads a small trump; Knave is put on it, and I take the trick with my Queen. I know now that my partner holds the Ace, and opponent the King. Quite probably both the remaining tricks in trumps will go to my partner, if only opponent be compelled to lead trumps at the last. (The enemy are sure to make some tricks in plain suits.) Probably my left-hand opponent, if he has any strength at all, has it in Spades. I lead a Spade, and the trick falls to my right-hand opponent's Queen. He leads a Spade, and left-hand opponent takes the trick with the Ace. A Spade is again led, which I take with my King. I lead my Heart Queen, which is captured on my right by the King. The Ace of Hearts, led on my right, makes another trick for the enemy. Then my right-hand opponent having to lead from the second and fourth best trumps, my partner holding best and third best, *both* the remaining tricks fall to my partner. We make two by tricks.

This game is a simple, and in a sense familiar, example of the value of correct play, and of the interest of a game correctly played. For, though no two games of whist are exactly alike, there are certain types of play which are often reproduced. In this game a good score was made against a strong hand by following a principle

which is repugnant to all the notions of the family whist-player—viz. leading from a suit which is exhausted in the enemy's strong trump hand. With five trumps headed by the King, Knave; four Hearts headed by the Ace, King; and a guarded Queen of Spades in one hand, with the Ace of Spades in the other, the enemy made only five tricks in all—viz. one in trumps, two in Spades, and two in Hearts. Without entering into details of play, it is certain that, had the methods of family-whist been pursued by myself and partner, the enemy would have made three tricks in trumps, two in Spades, and three in Hearts, or eight tricks instead of five—a difference of four points in scoring, since it would have altered our "two by cards" for us into "two by cards" for them.

I will not assert that the success actually achieved was *assured* by the course pursued. My judgment of the chances at the third trick, though sound in principle, might well have been inconsistent with the reality. My opponent on the left *might* have been able to ruff, the Knave lying with his partner. The odds were about five to two against this; *but* although, whenever you are sure to be right five times out of seven in following a particular course, you ought certainly to follow it, you must remember that you are equally sure to be wrong twice out of seven, in the long run, on that course. That is what the family whist-player seems unable to understand. "If you had not done so and so," he will point out, "such and such splendid results would have been obtained." And if you answer, "That was only the case because the cards chanced to lie in such and such a way, which there was no means of knowing," he will answer (or think, if he do not say it), "A bad workman complains of his tools, and a bad whist-player of his cards." But there is, in fact, nothing more certain than that, in the long run or majority of cases, you gain at whist by steadily playing according to the best view you can form of the chances, while yet you must inevitably lose by so doing in a certain proportion of games played. Thus that *crux* for the family whist-player, the lead of the King from King, Queen, and others, turns out unfavourably in about two hundred cases out of five hundred and fifty; *therefore* it is not the wrong course, but the right.

Now I think it cannot be doubted that a game played in this way, with constant attention to the various points arising as the game proceeds, and with constant reference alike to the evidence already obtained and to the chances in regard to such points as still remain in abeyance, must be a far more attractive game, and therefore far more valuable as a recreation, than that family-whist in which the only point considered is how to make, at once, all such strong cards or points as chance may have thrown into the hand.

For this reason, were there no other, I should be an advocate of scientific whist, as against the chance game called, by those who take part in it, "Whist," but more correctly—though perhaps less euphoniously—denominated "Bumblepuppy" by those who know the real game.

A GOOD JOKE, OR NONE?

If the following from the *Australasian* (in which uncommonly good whist is given, by the way) is really a good joke at my expense, I can see no reason why it should not be presented to the readers of KNOWLEDGE for their enjoyment, which may be enhanced if I mention that I retain the opinion at which the *Australasian* smiles:

"We must direct the attention of every person who can enjoy the fun of an unintentional joke to the following example with which Mr. Proctor presents his readers: The 'echo' in modern conventional whist is the intimation by which a player announces that he has been keeping his eye on the table, and has noticed his partner's 'Peter' or call for trumps. In the nature of things, then, it is evidently impossible that the 'echo' can be heard as often as the 'call' to which it is a response. Yet Mr. Proctor gravely asserts that 'occasion arises oftener for the echo than for the Peter.' This is certainly one of the most delightful examples of an unconscious blunder, of the nature of an Irish bull, with which it has ever been our good fortune to meet in a book written by an Englishman."

This occurs in a review of my "Home-whist." I hope I shall not in any way impair the joke by mentioning what I have rather insisted upon in "Home-whist," that the "echo" is enjoined by the signalling school, not only in response to the Peter, but also to the trump lead from strength. Since trumps are led from strength at least ten times as often as the Peter is displayed, it appears to me not at all miraculous that in actual play I have at least thrice as often had occasion to note the echo in either its negative or positive form, as the Peter or signal for trumps.

Some players, I may remark, scarcely ever signal for trumps—and one wishes the number were much greater, seeing that the frequent signallers are invariably bad players. Yet, so long as the present system (scarcely honest in my opinion) is followed, each of a pair of partners who both avoid the Peter is bound to echo to his partner's trump lead from strength when holding four trumps or more, unless he has definitely explained that he does not wish to follow the modern signalling methods in any respect. For if he does not, due occasion arising, he misleads his partner.

Our Chess Column.

BY "MEPHISTO."

THE nineteenth game of the recently concluded match between Steinitz, the "Champion of the World," and Zukertort, the hero of the London tournament, is in many respects a remarkable contest. The opening moves of this game demonstrate with forcible and realistic evidence the decisive advantage gained by correct play in the opening, or otherwise the opposite or disadvantageous effects produced by a faulty beginning. These are truisms for which we have always contended; but very seldom have we had an opportunity equal to the present of demonstrating these facts from the actual play of two great masters. It is a remarkable occurrence, especially considering the gravity of the occasion, that in such an important match-game the second player obtained practically a winning advantage as a result of the first nine moves. This the game will show.

Steinitz having proved himself superior in pure reasoning or mathematical play, then follows up his advantage by imaginative efforts, pleasing and vivacious in conception, and rendered all the more impressive and beautiful (to the connoisseur) by the correctness of play, based on which, the combinations are superposed. If there really was any need for demonstration, this game would furnish the proof that the highest excellence can only be obtained by a combination of pure reasoning, with imaginative combination. The stronger and truer the former, the more effective and impressive the latter. But neither quality by itself alone can elevate its possessor to that highest state of perfection which commands our admiration.

Figuratively speaking, there may yet be found many children of nature "who prefer the proverbial blue Daniel and red lions" to many a picture where the colouring is finer toned. In a less degree we find many chess-players giving preference to games, which to them seem to abound in combinations of the liveliest sort, which in reality, however, are of a more or less commonplace kind, mostly unable to endure analytical tests—i.e. resting and relying chiefly upon inferior play, a kind of performance not requiring the very highest abilities.

We cannot, however, accord to the whole match the eulogium we have bestowed upon this particular game. It was evident that both players were subject to spells of indisposition, during which they produced indifferent games; for while Steinitz, unlike himself, lost four games running by sheer blunders, Zukertort can hardly be said to have done his play justice towards the end of the match. A few very good games have, however, been played. This match, in one respect, teaches us the same lesson as the London tournament of 1883. That is this: high amounts of money do not in chess yield results relatively superior to those obtained on occasions where smaller sums were contested for. It is, of course, essential to offer substantial prizes in tournaments and matches, to induce the best possible competition; but we should much rather like to see three tournaments arranged for 1,800*l.* than one. The same remark applies to matches.

Bearing upon this subject, we may mention the efforts made at present to arrange an international tournament in London for July next, by the committee of the British Chess Association. We feel convinced that if about 300*l.* were subscribed a very interesting tournament would be arranged.

Nineteenth game of the match, played at New Orleans, March 24, 1886.

White, ZUKERTORT.	Black, STEINITZ.
1. P to Q4	1. P to Q4

(The reader will do well to take Black's side of the board.)

2. P to QB4	2. P to K3
3. Kt to QB3	3. Kt to KB3
4. B to Kt5	4. B to K2

The usual course followed in this opening by White, is to place his own game on a safe basis by castling first; whereas here White has played three moves, which Black utilised for his own development. White's K side is still blocked. Such weak points are not necessarily fatal in themselves; with care they may be redeemed, or even turned to advantage. We are, however, anxious to impress upon our readers that to have a difficult game to play is already in

itself a disadvantage. Every additional incorrect move will augment the disadvantage, not in mathematical but in geometrical proportions.

5. Kt to B3	5. Castles
6. P to B5	

White would still have been in time for securing a safe development by playing 6. P to K3, &c. Now he offers Black an opportunity to disorganise his Queen's wing, which is weakened by the absence of the white QB, and the undeveloped state of White's K's side.

6. P to QKt3.

The proper move. If White takes this Pawn, Black would reply with RP × P, and have the advantage of the open Rook's file, which at the disposal of a Steinitz means facilities for winning a Pawn. Advantages, besides being cumulative, are also, as in this case, interchangeable. By playing P × P, White might have gained time for the development of his King's wing at the expense of weakening his Queen's side.

7. P to QKt4

There is no other alternative to playing P × P, but with every move that Black gains in development White's position becomes more precarious.

7. P × P

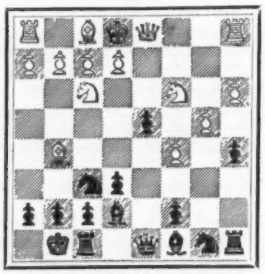
8. QP × P

If 8. KtP × P, Black might have played B to R3 in reply, preventing White's P to K3. But although White would still have had an inferior and difficult game, KtP × P was preferable to QP × P.

8. P to QR4

9. P to QR3	9. P to Q5

WHITE.



BLACK.

A very effective move, which gives the game a decided turn in Black's favour. Neither Kt × P nor Q × P is available in reply to this ingenious device. If 10. Kt × P, P × P. 11. P × P, R × R winning a piece. Or if 10. Q × P, P × P. 11. Q × P, Kt to R3 winning the ill-fated QBP.

10. B × Kt

In the hope that the black KB would be diverted from bearing on the white QBP, also to gain a square on K4 for the Kt, which cannot retire to Kt sq or R2 without losing a P by Black playing P × P.

10. P × B

Good judgment. The B still remains on K2 attacking the P's; the Kt could now be driven away should he play to K4, and finally Black can form a strong centre by P to K4.

11. Kt to QR4	11. P to K4
12. P to Kt5	

Necessary in order to prevent either Kt to R3 or B to Q2, both moves being calculated to break up the Q's Pawns.

12. B to K3

This is another very deep move. White can now apparently play 13. P to B6, blocking Black's QKt and QR. But Black had his reply ready—i.e. 13. P to B6, Q to Q4. 14. P to K3, Q to Kt6 (threatening Q × Q, followed by B to Kt6). 15. B to K2 (best), P × P, with a fine game.

13. P to Kt3	13. P to B3

Black forces White to take the P, whereby he brings out his QKt, supports his QP to enable him to advance P to K5. If White play 14. P to Kt6 instead, both these Pawns could not resist the combined attack of Black's pieces very long, and would fall. Q to Q4 now would not be so good as in the analysis of the former note, as White would gain important time by playing 14. B to Kt2, which would prevent Black from playing B × QBP for the moment, on account of 15. Kt × B, Q × Kt. 16. Kt × P, opening on the black R, &c.

14. P × P	14. Kt × P
15. B to Kt2	15. R to Kt sq.!

Avoiding possible inconvenience, and attacking at the same time.

16. Q to B sq 16. P to Q6!

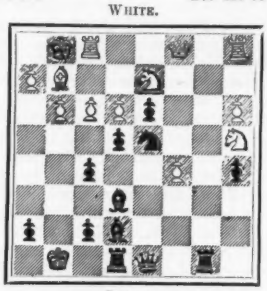
Whatever may be said of White's play, it will not be denied that Black takes advantage of it in masterly manner. If White now plays 17. P × P, Q × P would domineer White's game entirely.

17. P to K3	17. P to K5
18. Kt to Q2	18. P to B4
19. Castles	19. R to K sq!

All things considered, White has got well over his difficulties, although considering the position of Black's Pawns, and the weakness of White's QBP, Black has a decided advantage in position for an end-game. We imagine that Black's last move was intended as a subtle waiting move:

20. P to B3	20. Kt to Q5!

WHITE.



BLACK.

One of the excellent moves in which this game abounds. White, of course, need not have played P to B3. But, as we said in our introductory note, a difficult game is a disadvantage in itself, for the reason illustrated here—namely, there are so many chances of going wrong.

21. P × Kt

Black threatened Kt to K7. If White had played 21. K to R sq, Kt to B7 followed by Kt × QP, &c.

21. Q × P (ch)

22. K to R sq	22. P to K6!

Disdaining to take the Knight, and certainly the better part of the combination.

23. QKt to B3.

No doubt his best chance.

23. B to B3!

This is beautiful play, especially as one fine move follows the other. If Black had played P × Kt, then 24. Q × P with less to fear than at present. Now Black temporarily gives White a chance to withdraw his piece, as will be seen, not without good reason.

24. Kt (Q2) to Kt sq	24. P to Q7.
25. Q to B2	

White could not play Kt × P without losing the other Kt as well.

	25. B to Kt6
26. Q × BP	26. P to Q8 (Q)
27. Kt × Q	27. B × Kt
28. Kt to B3	28. P to K7!
29. QR × B	29. Q × Kt!

Resigns.

We may point out that in the whole of this game—every move of which forms a study in itself—Black has not once withdrawn any piece, not even the Queen, from the place to where it had been played to effect its purpose, except in order to advance and occupy better positions.

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